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DISEASES OF SWINE

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Diseases of Swine.

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GENERAL STATEMENT.

This brief monograph upon the diseases of swine is presented with the view of giving some help to the numerous breeders of swine. It is not offered as a complete treatise—just as a little helper. The swine breeder can not purchase books upon the diseases of his animals as may be done upon the diseases of horses or cattle, as there are few works that treat upon the subject. It has been only a short time since it was thought to be easier and cheaper to raise a new lot of pigs, than to give much attention to treating their diseases. This condition is rapidly changing. Individual hogs now bring the price of a good horse so often, that the same attention is demanded in caring for them. The number of hogs that bring more than one hundred dollars each, has rapidly increased in the past few years and an occasional animal brings more than a thousand dollars. The annual production of swine amounts to more than $20,000,000 in this State. There are more persons engaged in raising pigs than in any other part of the live stock industry except poultry. The annual losses reach about $2,000,000, so there is demand for information that will help to reduce this loss both by prevention and treatment. This is further shown by the fact that there are more inquiries concerning the diseases of swine than are made concerning the diseases of cattle and horses.

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DISEASES IN GENERAL.

As a matter of convenience and to aid in understanding diseases, we divide them into three classes, sporadic, contagious, and infectious. This classification is purely arbitrary and is based upon the nature of the cause. Sporadic diseases are those which have no one constant cause. A variety of causes may produce the same disease. Colic, diarrhoea, rheumatism, colds, etc., are types of sporadic diseases. Colic for example may be caused by a change of food, by green food, by spoiled food, by watering when the animal is too warm, by contaminated water, by drugs, by exhaustion, by exposure, by intestinal worms, etc. There is no single cause for colic, colds or any other sporadic disease. In sporadic diseases, the disease can not be conveyed from one animal to another as there is no specific germ or other organism acting. If several animals are affected alike at the same time, it is because all have been subjected to like causes and not because it has spread from one to another. As a rule, only one or a few animals of a stable, herd or flock are affected at one time and there is no tendency to spread.

Contagious diseases are those which are always produced by the same cause, and the causative factor may be communicated from one animal to another of the same species, or in some cases to animals of different species. When we speak of strictly contagious diseases, we usually have reference to those due to germs, or animal life that are normally parasitic and do not live or multiply outside the body, and which require comparatively close contact in order to spread. Distance, or a comparatively short time between the coming of animals to the same place are sufficient to prevent the spread. In other words, the germ does not pass an indefinite distance between the animals or live for a long time outside the animal's body. As examples of this type of disease, we have sheep scab, tape worms, glanders; pleuro pneumonia, etc. In the case of sheep scab the cause is always the scab mite; it can not travel alone and will not live in the pens, in the cars, on the fences or other objects with which the diseased sheep may come in contact for a long time. Therefore sheep separated by a roadway, or flocks using the pens where diseased sheep have been some months prior do not become affected. Pleuro pneumonia in cattle is also a contagious disease and at one time had a foothold in this country. It is a disease in which the germ does not live long

outside the body and is only carried by contact or artificial means. It was eradicated by destroying all that were affected and disinfecting the places where it had been. Glanders among horses is also contagious and it is only spread by contact or close association. All strictly contagious diseases are controllable and could be exterminated by united effort. The drastic measures used to stamp out pleuro pneumonia would stamp out sheep scab in a short time.

Infectious diseases are those caused by some special agent or parasite and the cause may live and multiply outside the body. Infectious diseases may be and frequently are contagious. Some infectious diseases however are not contagious. The line separating contagious and infectious diseases is not very clear. The distinction is largely one of degree. Among the types of infectious diseases we have lumpy jaw, and blackleg of cattle; distemper, and influenza of horses, cholera, and swine plague in hogs, and roup in poultry. True lumpy jaw of cattle is always caused by ray fungus. The fungus is obtained upon the food which the animal takes, the disease is rarely spread by the discharges from the wound. Blackleg is obtained from the pasture or forage, the germs being known to live for a long time outside of the body. Influenza and strangles occur in epidemics because the germs live outside of the body and under favorable climatic conditions develop generally, thus causing widespread outbreaks at the same time. Hog cholera and swine plague are both infectious and contagious, the germs live outside the body and no amount of separation of herds will ever stamp out the diseases. It only decreases the number of cases. The germs of tetanus or lock jaw are to be found growing in the soil, but do not cause trouble unless accidentally introduced into a closed wound. Infectious diseases can not be wholly controlled because the occurrence in an animal is not essential to the life of the germ. Some may be prevented by vaccination, as blackleg, and some have been greatly reduced by learning the habitat of the germs outside of the body and making those places uncongenial for their growth.

THE CAUSES OF DISEASE.

The causes of disease are the indirect or predisposing causes and the direct or exciting causes. The predisposing causes are any factors which

tend to render the body more susceptible or to favor the presence of the exciting cause. The exciting cause is the specific agent or thing that induces the diseases. To illustrate, an animal having a narrow, pinched chest may be in health but when subjected to the same conditions as its companions, it contracts disease while they do not. The lessened lung capacity has rendered the animal susceptible. Hogs pastured on high dry ground and fed on clean feeding floors are generally free from intestinal worms, while hogs pastured upon low wet ground and fed in the mud are frequently infested with worms. In the first case the predisposing cause was in the animal, in the second, it was in the surroundings. Among the causes of disease we may briefly consider the following:

Age.—Young animals are more subject to attacks of contagious or infectious diseases than old. White scours, suppurative joint disease, and infectious sore mouths are diseases of the first few days or weeks. Thumps occur early. Cholera occurs with much greater virulence in those under six months of age than in the older. Lung worms or whooping cough occurs between two and four months. Swine plague attacks the older hogs. Trichinae likewise more often occurs in mature animals. As a rule, the young are more subject to acute diseases and the old to chronic troubles.

Sex.—The matter of sex has little bearing on the diseases of swine other than those due to farrowing.

Breed.—The matter of breed is of less importance in the diseases of swine than in other domestic animals. Some breeds are more active than others and thereby seem to have increased resistive powers to some troubles. For example, pigs from the more active breeds seldom have thumps if allowed exercise. It is the lazy, fat fellows that are particularly susceptible.

Care and Feeding.—These are factors of great importance. The feeding of unsuitable foods, as city swill, dirty, sour slop, those containing large quantities of soaps, feeding too heavily when too young, feeding full rations of green corn as soon as it is ready, feeding cotton seed, feeding with too limited exercise, pasturing upon clover sod where there are many grub worms and upon land known to be infected with parasites, are all factors contributing to some forms of disease.

Shelter.—Sudden changes of temperature, extremes of heat and cold,

exposure to storms, etc., all have their effect. Piling under straw stacks and hot sheds prediosposes to pneumonia. Lying in damp beds causes skin troubles. The hog does not need a great deal of shelter, but needs that dry and comfortable.

Location.—Sometimes the difference of a few rods makes the difference between having disease in a herd and not having it. A dry, protected site is always preferable to one in the open or low.

Water supply.—The work of this Station has been such as to prove that only well water, deep well water from a tubular well, can be recommended for all kinds of farm animals. This applies with possibly greater force to the hog than to any other class because cholera, a water borne disease, is the principal scourge. In actual practice, however, the reverse condition prevails.

Previous disease.—The effect of one attack of an infectious disease as a rule confers immunity against a subsequent attack. This is not true of all, but of many. One attack of cholera will not give complete immunity, but does reduce the chances of a second attack. The effect of one disease may weaken a part and make the animal susceptible to some other trouble, as lung worms may make it easy to acquire pneumonia.

Vital causes.—The vital causes are all living organisms, either plant or animal, that act as parasites at any stage of their existance. They may be either accessory or direct causes. The animal parasites are lice, intestinal worms, flukes, trichina, etc. The plant parasites are nearly all bacteria; the cause of cholera, swine plague, scours, joint disease, sore mouth, etc. They may act as accessory causes, as the lung worm may prepare the way for pneumonia, or directly cause it, as in the case of the cholera germ.

DIAGNOSIS AND SYMPTOMS.

In examining a hog the behavior, appearance, general conditions and surroundings must all be taken into consideration.

The grouping of symptoms into signs of disease is not as difficult in the hog as it is in some of the other farm animals, but in order to recognize any deviation from the normal, we must be familiar with the habits of the animal, the structure and the physiological functions of the

body, or at least possess a practical knowledge of these things. Swine breeders have plenty of opportunity to learn this from personal observation; without this knowledge it is not possible to care for, or treat hogs in an intelligent manner when sick.

The general symptoms, those affecting the entire system, inform us as to the condition of the animal at the outset and during the progress of a disease. Thus we have the symptoms connected with (a) the pulse; (b) the respiration; (c) the body temperature; (d) the mucous membranes; (e) the surface of the body; (f) the secretions and excretions: and (g) the nervous system.

All of the general symptoms manifested by the hog are seldom considered either in the diagnosis or the treatment of disease. There is no reason, however, when treating valuable stock hogs, why a full knowledge of the condition of the animal should not be of the same importance as in the treatment of other domestic animals, and if possible this should be obtained.

Pulse—The pulse can be easily taken in the hog from the femoral artery on the inner side of the thigh. The artery crosses this region in an oblique direction and is quite superficial toward the anterior (forward) and lower part. The normal number of pulse beats per minute is usually estimated at about seventy to eighty. In young pigs, and when the animal is exercised or excited, the rate is much higher.

The following varieties of pulse are recognized in disease: frequent or infrequent, quick or slow, large or small, hard or soft and regular or intermittent. The frequency of the pulse has reference to the number of pulsations per minute; quick or slow to the time required for the pulse wave to pass under the finger; large or small, to the volume of blood that passes at each beat; hard or soft to the sense of feeling while the blood is passing under the fingers; and regular or intermittent to the intervals between the beats. There may be a number of beats regular and in time and then the missing of one or two, or there may be increased rapidity of a few beats and then a decrease. The condition of the circulation may also be judged by placing the hand on the left side of the chest and as nearly over the heart as possible.

Respirations.—The number of respirations per minute is subject to considerable variation. When at rest, they will vary from ten to twenty;

if warm or excited and during exercise, from sixty to about one hundred. In hogs, normal respirations are frequently accompanied by respiratory sounds. In disease the respirations may be quickened and their character changed, as in pleurisy, peritonitis, pneumonia, etc. In the abdominal form of respiration, the movements of the walls of the chest are limited. This occurs in pleurisy. In the thorasic form of respiration the abdominal wall is held rigid and the movement of the walls of the chest make up for the deficiency. This latter condition is seen in peritonitis.

In inflammation of the air passages and irritation from dust or parasites, the secretions from the lining membranes are modified and there is usually sneezing or coughing. In the different diseases of the respiratory organs, the modified sounds are of much value in the diagnosis and in indicating the progress.

Temperature.—The body temperature is taken per rectum, the ordinary fever thermometer being used. The normal temperature of a hog will vary from 100.5 to 105 degrees Fahrenheit, the average being about 103. In order to determine the normal, it is well to take that of some of the other animals in the pen and make a comparison. Exercise and warm pens will increase body temperature, cold weather and drinking cold water will lower it.

Mucuous Membrane.—In health the visible mucous membranes are usually a pale reddish color, and when inflamed, they are a bright red. In collapse, internal hemorrhage, impoverished or bloodless conditions of the body the membranes are pale.In indigestion, that lining the mouth may appear coated; if irritated, excessively moist; and if the hog is feverish, dry. In serious diseases, especially febrile disturbances, secretions may accumulate around the margins of the eyelids and the eyes appear dull.

Skin.—Healthy hogs should have a smooth, rather heavy, glossy coat and the skin feel mellow and soft. When the skin loses its elasticity, becomes hard, rigid and scurvy and the hair rough and harsh, it indicates a lack of nutrition and an unhealthy condition of the body. When the coat is thin or the hog affected with external parasites, irritation from the sun and parasites may cause it to become greatly changed.

Excretions.—The character of the excretions from the kidneys and bowels become modified in some diseases, and should be considered in making a diganosis.

Nervous System.—The state of the nervous system is indicated by dullness, excitably, or delirium. The hog may stagger, walk stiffly, drop the head, turn the head to one side, walk in a circle, have convulsions or show paralysis of a part of the whole body, as a result of nerve involoment. These symptoms may occur as an involvment in several diseases, or arise from primary affections of the nervous system.

ADMINISTRATION OF MEDICINE.

The diffrent methods of giving medicine are as follows: (a) by way of the mouth, in the feed or as a drench; (b) by injection into the tissues beneath the skin; (c) by rubbing into the skin; (d) by the air passages and lungs; (e) by the rectum.

By way of the mouth.—Hogs possess a rather simple digestive tract, and are very susceptible to the action of drugs when given in the feed or as a drench.

If the hog is not too sick to eat and the drug does not possess an unpleasant taste, it can be given in the feed. If soluble, milk can be used; if insoluble, ground feed is to be preferred. In all cases the medicine must be well mixed with the feed. When a large number are to be dosed it is best to separate them into lots of ten and feed each lot separately. When this is done, there is greater certainty of each getting the proper dose and the danger from overdosing is avoided. In the case of young pigs, we can take advantage of the fact that some drugs are excreted in the milk, and administer the drug to the mother.

Drenching a hog is not difficult if quietly and easily managed. A large herd can be drenched quite rapidly if driven into a small pen, as the hogs will be in such close quarters that they can not get away. To secure the hog while drenching it, a noose of sash cord or a small rope can be placed around the upper jaw well back toward the angles of the lips, and the medicine administered with a metallic dose syringe. Sometimes when the drench is bulky, and the hog hard to hold, it is necessary to elevate the head and raise the fore feet off the ground. For this purpose a pulley and a rope wire stretcher is recommended. It should be hung in some convenient place in the pen and the animal secured in the usual way by placing a noose over the upper jaw. The rope is then thrown

over the hook in the lower pulley and the hog drawn up until it is almost off its feet. The drench must not be administered until the hog is quiet and well under control, as there is some danger of the medicine getting into the air passages and doing harm. If there is danger of the hogs getting mixed in the operation, as soon as one is drenched it can be marked with paint.

Drugs, when soluble, are best given in water or milk; when insoluble, in syrup or oil. Instead of a syringe a long necked bottle, or a funnel with rubber tubing and an iron nozzle can be used.

By injecting into the tissues beneath the skin.—This method of administration is suitable when the drug is non-irritating, the dose small and when prompt, energetic effects are required. The needle and hypodermic syringe should be sterile, and the place of injection washed with an antiseptic wash in order to prevent the formation of an abscess. The point of injection should be where the skin is thin, as the flank, belly, ear, or inside of thigh. The needle is introduced through the skin and the medicine injected beneath it by slowly pushing the piston. In the case of fat hogs the injection should go into the muscular tissue; otherwise it will not be absorbed promptly.

By the way of the air passages and lungs.—This method of administration is practiced but little, and usually for a local effect on the respiratory organs only. The hog or hogs, are put into a tight enclosure and allowed to inhale vapors of the drug. Drugs suitable for this purpose are turpentine, creolin, eucalyptol, sulphur, etc. Turpentine is the one most used and is easily disseminated by pouring on hot water or by putting an ounce or two on hot bricks. Care must be exercised when treating hogs in this way, as they may suffer from lack of air.

By the way of the rectum.—Enemas or clysters are usually given for a local effect on the rectum or to accelerate the action of a purgative. To administer an enema a fountain syringe is best. The nozzle of the syringe should be smeared with vaseline before introducing it into the rectum. When the injection is large, it is well to elevate the hind parts of the hog. A gallon or more can be introduced into the intestines in this way. A funnel and rubber tubing, or an ordinary syringe can be used for this purpose.

PREVENTIVE TREATMENT.

Preventive treatment is recognized by all successful hog raisers as the most successful and economical method of combating disease, and it is along this line that the greatest attention should be directed. Disease is best combated by correcting the faults in breeding and feeding, by good hygienic surroundings, by ample exercise, fresh air and sunlight, clean yards and pens, and the free use of disinfectants.

DISEASES OF THE DIGESTIVE SYSTEM.

STOMATITIS.

Sore Mouth.

Causes.—Putrid or decomposing slops, irritating or hot foods, drenches, the water in foul wallows, especially that containing much seepage from the manure pile, are among the common causes of simple stomatitis in swine. Decayed teeth, irritation from awns or beards of grasses, as barley and wheat, in the feed, and rope loops used in catching hogs may also cause it. Circumscribed inflamed patches on the mucous membrane of the mouth are sometimes seen in hog cholera, swine plague, anthrax, actinomycosis, and other diseases.

Papilloma of the tongue. A warty growth seen on the tongue in rare cases.

Symptoms.—The mucous membrane of the mouth is hot, dry and red in appearance. Ropy saliva dribbles from the corners. The animal champs the jaws and seems to find relief in running its nose into cold water. There is a disagreeable odor from the mouth. Mastication is painful and the hog shows a disposition to eat sparingly. Soft liquid food is preferred; hard food is imperfectly masticated and may drop from the mouth. Recovery usually takes place in a few days.

Treatment.—If due to irritating foods, the cause must be removed. Hard food should be withheld and nothing but sloppy foods be fed to the animal when in this condition. Plenty of cool, clean water should be placed where the hog can drink and run its nose into it. The medicinal treatment consists in washing the mouth twice a day with an astringent wash or antiseptic lotion. A four per cent. watery solution of boric acid or alum can be used for this purpose. The coal tar washes are also serviceable.

DISEASED TEETH.

The hog eats all sorts of objects and cracks nuts, coal, gravel, etc., upon the teeth, so that when the hog becomes old he is almost sure to have a bad mouth. Hogs sold for stock purpose are seldom affected in this way. Boars sometimes have very long tusks.

Symptoms.—The symptoms of some derangement of the teeth are pain upon grinding, holding the head to one side while eating, insufficient mastication, as seen in the half or whole grain passed, and inability to shell corn from the ear.

Treatment.—The treatment is to give largely ground or sloppy food, and pasture. Cut off with dentist's cutters all long tusks, but do not knock them out with a punch or cold chisel, as the latter method is almost certain to crack the teeth and fracture the jaw.

BLACK TEETH.

This condition is frequently brought to the attention of the veterinarian, but as yet we have no satisfactory explanation to offer for their presence. They are also found in health, as may be observed in heads at the slaughter house. Undoubtedly too much stress has been laid upon this condition. We are not inclined to attribute any disease to this condition upon the present evidence. In very young pigs, when this condition

is most frequently seen, there may be very long, sharp teeth present which it would be better to cut off. At the time of dentition, the temporary tooth may be present as a dark shell and the gums be made sore and cause the pig to hold the mouth open, to salivate, and to refuse food.

DEPRAVED APPETITE.

Causes.—Depraved appetite is due to a variety of causes and may occur as a symptom in different diseases. Faulty rations, especially if deficient in alkaline and earthy salts, lack of exercise, digestive disorders and a nervous condition may cause it.

Symptoms.—The hog shows an inclination to eat all sorts of indigestible substances, earth, sand, feces, bristles, rotten wood, etc. Sometimes they are quarrelsome and may attack one of their numebr and kill it. Sows will eat their young, usually at the time of birth. When thus affected they do not thrive as they should and may become quite thin.

Treatment.—The treatment is chiefly preventive, and consists in supplying to the ration whatever elements are wanting. The addition of charcoal, salt, wood ashes, etc., sometimes answer the purpose well when the other ingredients seem to be about right. When the affection is due to chronic indigestion, they should be given the proper treatment.

GASTRITIS.

Acute Indigestion.

Causes.—Overloading the stomach and spoiled foods, especially putrid swill, are common causes of indigestion. Alkaline washing powders and soaps, irritate the stomach and intestines and may bring about this condition. Poor care, exposure and intestinal worms may also cause it.

Symptoms.—The hog refuses food, is generally restless and may have colicy pains. It usually wanders off by itself, acts dull, grunts, lies down in a quiet place or stands with the back arched and abdomen held tense. It seems to like to hide itself in the bedding, litter around the manure heap or straw stack, and in the grass or weeds. When vomiting occurs early in the attack, recovery usually takes place in a short time. Sometimes the animal has a diarrhea. The body temperature may be higher than normal.

Treatment.—Feeds that will irritate the stomach or intestines should be avoided. It is desirable to induce vomiting as soon as possible by giving an emetic of ipecacuan, (twenty or thirty grains in a little warm water). This can be followed by two or three ounces of castor oil. The hog should be kept in the pen and fed on easily digested ration.

CHRONIC INDIGESTION.

Causes.—When the causes of acute indigestion act for some time either in an intermittent or continuous manner, it will terminate in the chronic form.

Symptoms.—In the beginning these may be the same as in the acute form. The hog presents an unthrifty appearance and may become quite thin. Pigs grow slowly and may become badly stunted. We may observe constipation and diarrhea alternating.

Treatment.—Clean quarters and a well balanced, easily digested ration should be provided. The hog should have access to plenty of common salt and charcoal. As a tonic the following mixture can be given in the feed; bicarbonate of soda (two ounces), powdered gentian (three drams), sulphate of soda, (three ounces). The dose is about one teaspoonful twice daily. To check the diarrhea, give nitrate of bismuth in dram or half dram doses. If constipated, a cathartic of calomel (ten to twenty grains) will give relief.

GASTRO-ENTERITIS.

Inflammation of the Stomach and Intestines.

Inflammation of the stomach cannot be readily distinguished from that of the intestines and vice versa. Frequently both are inflamed at the same time. It is therefore more convenient to discuss both under the head of gastro-enteritis.

Causes.—This disease is largely due to unhygenic conditions. Some people seem to think that a hog can eat anything and take poison with impunity, and as a result, it frequently suffers from ignorant practice in the feeding, care, and giving of drugs. The causes of gastro-enteritis are much the same as in indigestion, only they act more intensely. We must

especially mention dirty, filthy yards and pens, decomposed and over kept foods. When hogs are kept in filthy quarters, the snout and food become soiled with all sorts of microbes. These enter the digestive tract along with the food, irritate the lining membrane and pave the way for those germs that would otherwise prove harmless. Toxic or poisonous substances, as salt brine, washing powders, dish water, etc., that are frequently found in the swill, may cause it.

Symptoms.—The animal shows evidence of severe abdominal pain. The back is arched, ears droop and the abdomen is tucked up. When the abdomen is pressed on, it will cause the hog to flinch with pain. Pain is manifested by grunting, squealing, restlessness, champing and grinding of the teeth. The body temperature is elevated. If the offending matter is fermentive or obstructive, there is bloating. When the stomach is involved, vomiting is a prominent symptom. The inflammation at first causes an intense thirst, and the bowels are constipated. Later a diarrhea is present. The hog becomes very dull and weak, and is generally seen lying down in a bed that it has rooted for itself in the litter.

There is no rule as to the duration of the disease. It may last but a short time or continue for a week or more.

Lesions.—The post mortem appearance is a congested and inflamed condition of the mucous membrane lining the intestines, sometimes involving the deeper layers of the wall and the peritoneum; the contents are mucous and flakey in character. The lymphatic glands are reddened and thickened, and if the inflammatory changes are due to a slow infection there may be small pouch like (follicular) ulcers in the mucous membrane.

Treatment.—The hog should be kept in clean quarters. If vomiting has not occurred, the offensive material should be gotten rid of by giving an emetic of ipecacuan (twenty or thirty grains in a little warm water). This can be followed by a laxative of castor oil, one or two ounces, or calomel in from ten to thirty grain doses can be given. To relieve the pain a teaspoonful of laudanum in about the same amount of linseed oil can be given. Rectal injections of soapsuds may be necessary to relieve the constipation. If diarrhea is a symptom of the disease, nitrate of bismuth in dram or half dram doses can be given two or three times a day. As a counter-irritant, oil of turpentine may be applied to the walls of

the abdomen and covered up until the skin is quite red. The best diet is well boiled, thin gruels. This should be fed until the hog is able to digest the ordinary ration.

TOXIC GASTRO-ENTERITIS.
POISONING.

Meat brine and washing powders are the most common causes of poisoning in swine, and are always accompanied by an inflammation of the intestines and stomach.

POISONING BY MEAT BRINE.

Brine from meat barrels and fish kegs is sometimes emptied where hogs have access to it and when eaten will cause an intense inflammation of the stomach and intestines. Hogs will not eat too much salt if they have access to it at all times, but the meaty taste of meat brine probably adds to their desire for it, and is eaten in large quantities.

Symptoms.—These develop in a short time. The animal is restless at first, will run from one place to another, lie down and get up again, stamp the feet and squeal. Vomiting nearly always occurs and a profuse watery diarrhea will come on if the hog lives long enough. Convulsions occur, during which it will throw itself around violently and froth at the mouth. The intervals between the convulsions become shorter and shorter as death approaches. The posterior parts are paralyzed and the animal will drag itself from place to place. The duration of the attack varies from a couple of hours to several days. The animal is sometimes suspected of being mad unless the cause be known.

Lesions.—Upon post mortem the lining membrane of the stomach and intestines is found loosened, sometimes in masses, and there is intense congestion of the entire wall and the peritoneum in contact with it.

Treatment.—The hog should be given all the water it will drink. Linseed oil in large doses can be given. Flaxseed tea is also useful. To quiet the pain, at intervals, a teaspoonful of laudanum can be given. Treatment is seldom successful.

POISONING FROM WASHING POWDERS.

It is a common practice to save the dish water as slop for pigs. Hogs fed on such slops often sicken and die, the symptoms and course of the

disease being very much like cholera and are frequently confused with this disease.

Symptoms.—These are diarrhea, vomiting, fever, lameness, partial paralysis, nervous disturbance and death. The course of the disease is from a few hours to several days, apparently depending on the amount of alkali ingested at one time. Death occurs in the majority of cases.

Lesions.—Upon post mortem examination, the lymphatic glands along the bowel are found swollen and dark colored. The mucous membrane lining the intestines is pale and shiny. Other internal organs are also involved.

Treatment.—The treatment is wholly preventive and consists in avoiding the feeding of slops containing these alkalies.

POISONING BY FEEDING COTTON SEED.

Fatal results follow the feeding of cotton seed, whether given ground, roasted, raw, boiled or as droppings from cattle. Poisoning, however, is not always observed in hogs following cattle fed on this food stuff. The cause of the trouble has not been discovered, all attempts at getting an active extract from the seed having proven unsuccessful.

Symptoms.—The evil effects are not noticed until several weeks after using it as a food. In cases that have been observed throughout the whole course, there is first, dullness, staggering gait, labored breathing, spasmotic in character and usually called thumps, loss of sight, restlessness, walking in a circle and running into obstructions, lying down flat on the belly, and finally sudden exhaustion and death. In the majority of cases, the animals are found dead in their beds or pens ten or twelve hours after they had apparently been in the best of health.

Lesions.—A post mortem examination gives no definite lesions and fails to show any effect that might be attributed to the hulls.

Treatment.—The only treatment that can be recommended is preventive, avoid using cotton seed in any form as food for hogs for more than two weeks at a time.

ERGOT POISONING.

Causes.—Hogs may be poisoned by eating the screenings from the thresher or elevator that contains considerable quantities of this fungus.

It may possibly be produced on psture, particularly rye pasture. This fungus occurs principally on the heads of rye. The disease is not common and when reported in this State, it has almost always been associated with the feeding of screenings and boughten mill feed containing large amounts of the screenings.

Symptoms.—These are lameness like rheumatism, local swelling and tenderness, especially about the joints of the feet although not confined to that region. Gangrenous spots occur upon various parts of the body. The extremities, especially the ears and tail, loose their natural warmth and vitality. Deep red spots that become black and gangrenous appear on the skin. The mouth may become sore. Parts of the ears and tail will crack and drop off and pieces may come out where gangrene occurs on other parts of the body. There is swelling of the eyes, loss of appetite and unsteadiness in standing or walking. In extreme cases the hog may loose one or more feet before dying. The disease may be confused with blood poisoning. The occurrence in several individuals at the same time will aid in making an early diagnosis.

Treatment.—Cut off the poisonous feed. Supply a soft, easily digestible diet. Give iodide of potash in ten to fifteen grain doses twice daily in slop.

EFFECT OF EATING WHEAT AND BARLEY BEARDS.

Frequently when hogs are turned on wheat or barley stubble some will die. The symptoms which they present will vary. In some cases it will be an intense sore mouth, in others a general bowel disturbance, and again in others, loud and difficult breathing.

Lesions.—Post mortem lesions, show beards in the mouth, stomach and windpipe. A roll of beards may form and get down by the side, or at the root of the tongue, and penetrate the mucous membrane. The animal cannot get rid of them and the parts become intensely swollen and inflamed, interfering with eating and starvation may occur. Plugs of beards may lodge at any point between the larynx and bronchi, producing loud distressed breathing and coughing. In the stomach there may be a slight inflammation of the lining membrane, and if the beards lodge in the membrane and do not soften and pass away, the inflammation is severe.

Treatment.—When the mouth becomes inflammed, the treatment is

the same as in simple stomatitis. Plugs of beards when lodged in this part of the digestive tract can be removed. If lodged in the air passages or stomach, they cannot be removed, and the animal dies from suffocation or an inflammation of the parts.

EFFECT OF EATING COCKLE-BURRS.

Numerous articles have appeared in the swine breeders' journals and agricultural papers indicating that young cockle-burrs were poisonous to hogs and calves. While the cockle-burr is young and only three or four inches high it is very fleshy and tender, and relished by stock. The claims of poisoning of stock attracted sufficient attention that the Indiana Experiment Station made a chemical examination and a feeding test to determine the poisonous properties, but in both the results were negative. The young plants, stripped of the burrs, were fed to calves, pigs, rabbits and guinea pigs. These were allowed all they would eat. In no case was any untoward effect noticed. We have been called upon to post-mortem some animals claimed to have died from such poisoning, and in all cases death was due to the burrs. A few burrs would be swallowed with the young plants, and their horny prickles would irritate the stomach wall and cause inflammation, which finally terminated in death. In three cases the burrs lodged in the throat and could not be expelled.

SCOURS IN YOUNG PIGS.

Causes.—Young pigs kept in damp, dark, dirty pens are more susceptiable to this disease than if kept in clean pens and allowed plenty of exercise, pure air and sunshine. Scours is often caused within the first few days after birth by the feverish condition of the mother affecting the character of the milk. Fermented foods, slops, moldy corn, etc., when fed to the sow will also cause her to give toxic milk. Chilly damp weather, getting out in the wet grass when young, and artificial feeding are most frequent causes. Some outbreaks seem to be due to a germ, as is the case in calves and lambs.

Symptoms.—These may set in so soon after birth that it would seem as though the pigs were born with the affection. When delayed until

the pig is a few days or a few weeks old, the scours are generally preceded by constipation. The symptoms of the trouble are loose evacuations, grayish in color, which become more and more watery as the disease progresses. The young animal may show some evidence of abdominal pain. The tail and hindparts soon become soiled with the discharges. The appetite may be good at the beginning, but is gradually lost and the pig becomes dull and weak. The back is arched, hair rough, and there is an indisposition to move about. When the symptoms set in soon after birth, the disease is more apt to prove fatal than if the pigs are several weeks old.

Treatment.—Scours being a disease due largely to bad dietetics and hygiene, the preventive treatment is of more importance than the medicinal. This consists in correcting errors in feeding and care. At the time of farrowing the sow should be fed a light, easily digested ration, the pen kept clean and dry and the pigs allowed plenty of exercise and pure air. If the scours are due to a feverish condition of the mother or to irritating food, she should be given two or three ounces of castor oil. To check the scours in the pigs, a few drops of laudanum can be placed on the tongue, or a large dose (from one-half to one tablespoonful) administered to the sow. This should be repeated if necessary.

DIARRHEA. SCOURS. DYSENTERY.

Causes.—Sudden changes in the feed, especially to green feed will frequently cause it. Diarrhea may occur as a symptom in inflammatory diseases of the digestive tract.

Symptoms.—Diarrhea in hogs is characterized by frequent and rather fluid exacuations.

Treatment.—When scours occurs as a symptom of disease, the cause must be removed before we can hope to treat it successfully. In all cases it is best to give a cathartic; castor oil (one to three ounces) or calomel (one to ten grains.) This should be followed by laudanum (half a tablespoonful), prepared chalk (one-half to one tablespoonful) or nitrate of bismuth (one teaspoonful). When any one of these drugs is used, the dose should be repeated as often as necessary.

CONSTIPATION.

Causes.—Constipation is caused by dry feed, lack of water, fever,

paralysis, or it may occur as a symptom of inflammation of the intestines.

Symptoms.—This is the opposite condition from diarrhea.

Treatment.—This consists in giving a cathartic of castor or linseed oil. Epsom salts may also be given. The action of the cathartic can be assisted by an enema. Sloppy food should be fed.

PERITONITIS.

INFLAMMATION OF THE PERITONEUM.

Causes.—Hogs are not as subject to peritonitis as most other domestic animals. It results from the extension of the inflammation from the intestines or other internal organs. Injuries to the walls of the abdomen, exposure to cold, and such operations as spaying and castrating may cause it.

Symptoms.—These resemble those seen in inflammation of the bowels. The history of the case may help us in the diagnosis. The hog is feverish and dull, the back is arched, abdominal walls rigid and the breathing short and quickened. There are indications of abdominal pain.

Treatment.—The treatment is mainly preventive. Such operations as castration, spaying, etc., should be performed under antiseptic precautions. Wounds involving the abdomen are serious and should be carefully treated. Medicinal treatment is of little use.

DISEASES OF THE LIVER.

Yellows Jaundice.

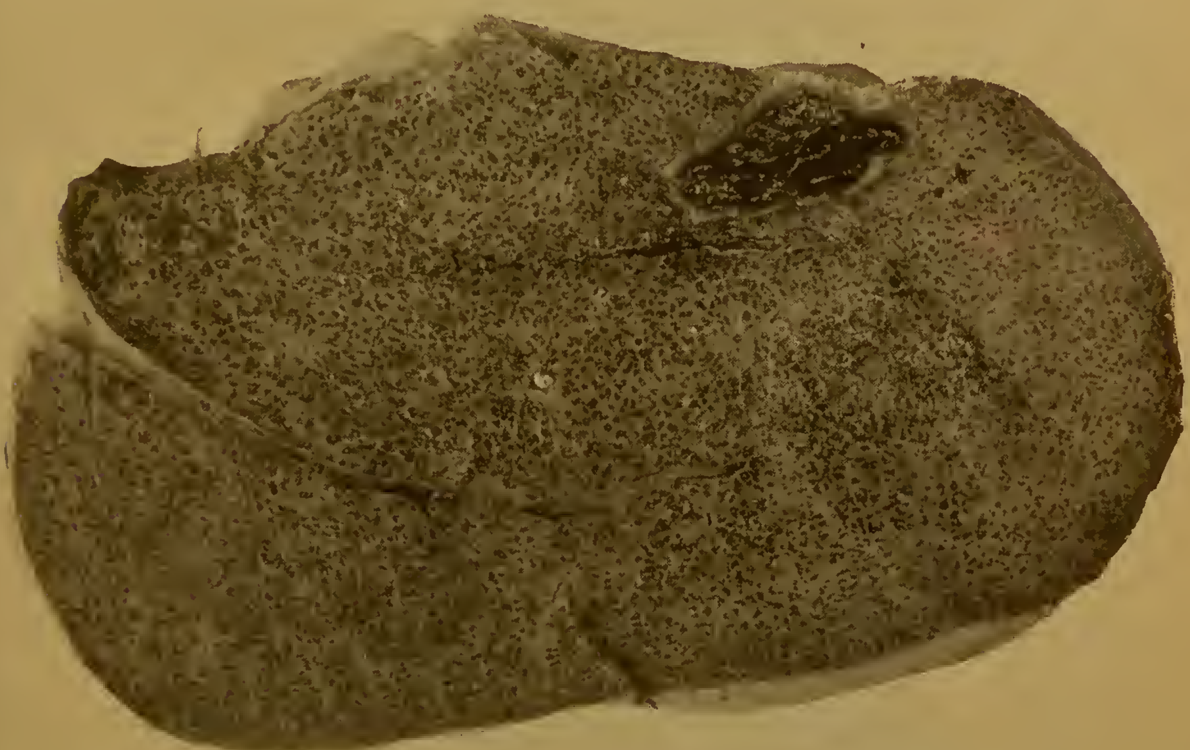
This is not a disease in itself but rather a symptom of disease, and is frequently associted with the following diseases: gall stones, parasitic diseases of the liver, inflammation of the intestines and bile duct, and congestion and inflammation of the liver. It is difficult to diagnose liver diseases in the hog, and quite impossible to differentiate one from another. For this reason it is best to discuss all liver diseases under the one head, jaundice.

Causes.—Gall stones are occasionally found in the hog and resemble fine sand in appearance. They may, however, occur as small calculi. The causes of gall stones are concentration of the bile, its becoming infected by bacteria, lack of exercise and over feeding.

Liver flukes and round worms may obstruct the bile duct as they

pass up from the intestines.. The former parasite is rare in this country and is seldom the cause of liver diseases in hogs. The round worms are sometimes found in the gall duct.

Inflammation of the bile duct may occur as a complication of indigestion or a catarrhal inflammation of the intestines. The main causes, however, are overfeeding, lack of exercise and decomposed food.



Pigmented liver. The liver is filled with dark spots.

Inflammation of the liver is frequently met with in infectious diseases. It may occur as a complication of indigestion. Certain micro-organisms entering the digestive tract with the food and finding their way to the liver may cause it to become inflamed.

Symptoms.—Any condition raising the pressure in the bile ducts or lowering the pressure in the blood vessels of the liver will cause the bile to be taken up by the circulation and carried to the different tissues of the body, staining them a yellow color. This is quite noticeable in the areolar tissue beneath the skin and in the fat, a condition sometimes met with in apparently healthy hogs killed in the abattoir. A staining of the visible mucous membranes and the skin cannot well be observed in the hog. Sometimes the coloring matter of the bile is present in the urine and the normal function of the kidneys is disturbed. Constipation usually

occurs and the feces have a more disagreeable odor than normal. When occurring as a complication of other diseases, the liver symptoms are usually overshadowed by the original disease.

Treatment.—The treatment is about the same as in indigestion. As a cathartic, calomel can be administered in from one to ten grain doses and repeated every other day for a few days.

DISEASES OF THE URINARY APPARATUS.

CONGESTION OF THE KIDNEYS.

Causes.—Congestion of the kidneys as a result of injury is not uncommon in hogs. Blows and kicks in the region of the back, or injuries occurring as a result of their piling up on each other, are among the common causes. Exposure, and wet, cold quarters, as in other domestic animals, may also cause it. It may occur as a complication of some infectious disease.

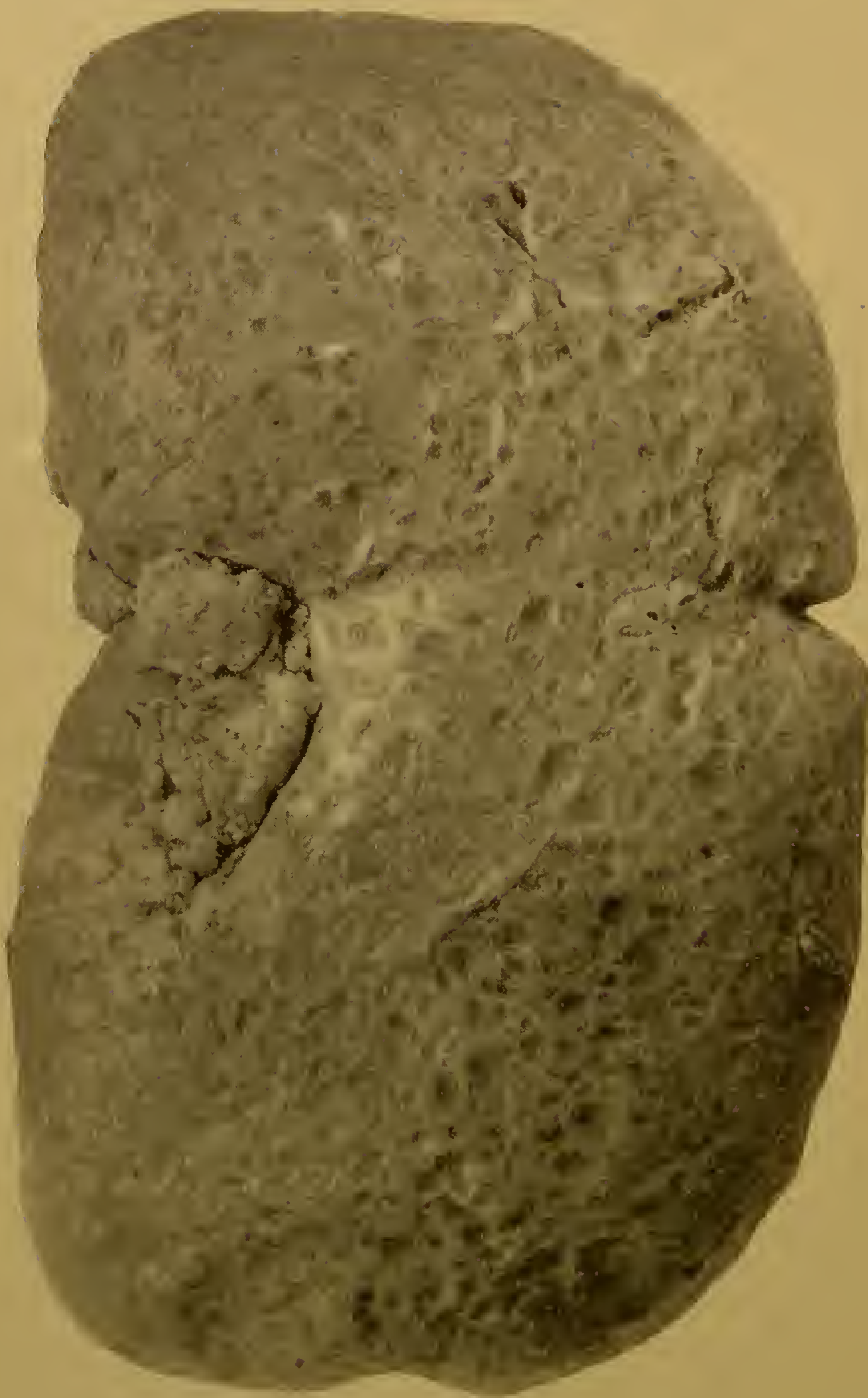
Contracted kidney. The kidney is reduced in size, is lobulated and hard. It is due to chronic inflammation of the fibrous structure.

Symptoms.—The pig shows a disposition to lie down most of the time. The hind parts are moved stiffly and the gait is stiff and straddling. Urine is passed frequently and in small quantities. It is higher colored than normal and may be tinged with blood. If due to an injury, these symptoms appear soon after it has occurred.

Treatment.—Preventive measures consist in avoiding as much as possible conditions that may cause the disease. The hog should be given dry,

comfortable quarters and fed on slops. It is well at the beginning to administer a cathartic of castor oil (one to four ounces). Hot water fomentations may be applied to the back and loins.

Tumor of the kidney.



Enlarged kidney. When cut through it shows cavities filled with urine. Due to chronic inflammation.

INFLAMMATION OF THE KIDNEYS.

Causes.—These are very much the same as in congestion of the kidneys, Irritating foods, such drugs as turpentine given internally and applied locally, and pathogenic germs conveyed to the kidneys by the circulation, or entering the kidneys by way of their excretory apparatus are frequent causes.

Symptoms.—The back of the hog may be quite sensitive to pressure. When it stands, the back is arched and held stiffly. The temperature may be elevated, the respirations and pulse beats quickened, and the urine is scant and highly colored. Convulsions may occur. Chronic inflammation of the kidneys may develop very slowly without giving rise to any noticeable symptoms until the disease reaches the later stages. Large abscesses are occasionally found in the kidneys of hogs apparently in perfect health when killed.

Treatment.—The preventive and medicinal treatment is much the same as in congestion of the kidneys. To insure free action of the bowels small doses of castor oil (from two to four tablespoonfuls) should be administered frequently. Diuretics should also be given.

DISEASE OF THE BLADDER.

Retention of the urine and inflammation of the bladder (cystitis) is sometimes met with in the hog. The retention of the urine may be due to spasms of the neck of the bladder, a cystic or urethal calculus, or from a tumor pressing on the urethra and preventing the flow of the urine from the bladder.

Treatment.—The treatment in both diseases is to remove the cause if possible. Inflammation of the bladder is due to retention of the urine and irritation from bacteria. To relieve the irritation, chlorate of potassium in from fifteen to thirty grain doses can be given twice daily. Pressure on the urethra by the tumor can be relieved by an operation in some cases. Keep the animal quiet and feed mostly sloppy food.

DISEASES OF THE SPLEEN.

Inflammation of the spleen is frequently mentioned in the older works on veterinary medicine, and an elaborate line of symptoms is sometimes given in connection with the disease.

Hypertrophy, atrophy and rupture of the spleen is recognized only by a post-mortem examination. These conditions may arise from an injury or the extension of inflammation from neighboring parts. Splenic hypertrophy is frequently seen in connection with high feeding and infectious diseases. Tumors of the spleen may cause it to become larger than normal.

DISEASES OF THE RESPIRATORY TRACT.

NASAL CATARRH.

Cold in the Head.

Causes.—Exposure to cold, especially if in an overheated condition or when the body is wet by rain, is the most common cause of catarrh. Hogs overcrowded in pens or allowed to sleep around straw stacks or manure heaps are apt to suffer as a result of overheating and becoming chilled, or by irritation from the dust and noxious gases generated under such conditions. This is especially true during the cold, wet weather when they pile up to keep warm.

Symptoms.—The hog may act dull, the body temperature may be elevated, and the eyes appear red and watery. The nasal mucous membrane becomes red and dry and the hog sneezes frequently. This dry stage lasts for a short time and is followed by a watery discharge from both nostrils, and in the more severe cases this is succeeded by a thick whitish or yellowish discharge. If this continues for some time the mucous membrane becomes markedly changed and ulcers form. Severe outbreaks are known as malignant catarrh. Nasal catarrh does not run a well defined course and may extend to other parts of the respiratory tract.

Treatment.—In the simple form of the disease medicinal treatment is not necessary. The hog should be fed warmed slop for a few days and a laxative (castor oil) administered. In severe cases in addition to this, inhalations of medicated steam (turpentine or creolin) may be given.

PHARYNGO-LARYNGITIS.

Sore Throat.

The causes and symptoms of inflammation of the pharynx and larynx in the hog are very much the same. This is also true of tonsilitis, and usually, all of these structures are involved at the same time, and can be discussed conveniently under the one head, sore throat.

Causes.—Sore throat frequently occurs as a complication of a bad cold. In addition to those already mentioned as causes of cold in the head are wallowing in cold springs and creeks when warm, being deprived of water and slops during a warm, dry season, close filthy pens, debility, entrance of septic germs along with the food and germs of hog cholera and swine plague.

Symptoms.—There is more or less fever, the eyes are red and watery and the animal is dull and may lie around the pen most of the time with its head buried in the litter. The appetite is poor and the hog may refuse food, because of the pain and difficulty in swallowing. Sometimes there is considerable restlessness. The respirations are noisy and the throat swollen. The cough may be dry, hard or spasmodic in character, often quite hoarse. There may be a discharge from the nose or mouth. In septic poisoning in the food and in infectious diseases, false membranes may form or the mucous membrane become gangrenous. The disease may develop rapidly and the air passages become closed by the swelling in a few hours and the pig die. Sometimes the animal dies as a result of the local ulceration or from general infection. In the less severe cases the disease runs a course of a week or more. In this latter form, if not caused by pathogenic organisms, recovery usually occurs.

Treatment.—The sick hog should be isolated from the healthy ones and given clean, dry, comfortable quarters. This part of the treatment is very important if the inflammation is due to septic organisms. Sloppy food should be fed and in cold weather it is best to feed it warm. Mild stimulating liniments can be applied to the throat. Sometimes a blistering ointment (powdered cantharides one part and vaseline eight parts) is applied to the skin in the region of the throat. An electuaria made of syrup three ounces and tincture of aconite two drams, can be given in teaspoonful or tablespoonful doses thrice daily. By confining the hog with a noose around the upper jaw the throat can be swabbed out with antiseptic washes (silver nitrate one part, water one hundred parts), or permanganate of potassium (two parts, water ninety-eight parts.) It is best to make the handle of the swab of wire or the hog may bite it in two. In acute attacks, or when the inflammed parts become gangrenous, treatment is of no use.

BRONCHITIS.

Causes.—These are the same as in common cold or sore throat. Bronchitis is frequently caused by irritation from dust or parasites.

Symptoms.—In the acute form the body temperature is elevated and the appetite impaired. The breathing is usually distressed and coughing frequently occurs. The disease does not run a definite course and may become chronic if the exciting causes are kept up. When this occurs, the pig does not thrive as it should and if the air passages are irritated in the least by dust, etc., it will cough violently. Coughing is especially prone to occur upon leaving the bed or after exercise. Pigs seldom die of this affection.

Treatment.—This is largely preventive. Good food and care are about all the treatment necessary.

PNEUMONIA.

Causes.—It is not uncommon for the inflammation to extend from the air passages to the lungs and the animal have a serious attack of pneumonia. Plethora is the principal predisposing factor. Among the exciting causes can be mentioned fatigue and impure air. In young hogs the lung worm will frequently cause a lobular pneumonia.

Symptoms.—Pneumonia may come on quickly, beginning with a chill and attended with a high fever, or as a complication of some other respiratory disease. The hog will remain down most of the time, hiding under the litter and will eat nothing or but very little. The respirations are hurried. Exercise is followed by marked exhaustion, sometimes by death. The cough is at first deep and dry, later more moist. During the first stage of the inflammation, the period of congestion, the cough may be accompanied by hemorrhage. Other symptoms will be revealed in thin, quiet hogs by placing the ear to the side of the chest and listening to the lung sounds (ausculatation). In the very earliest stage of pneumonia a crepitating sound may be heard in the diseased area, later when the engorgement of the air cells occurs, the healthy murmurs and the crepitating sounds are deadened. When the lung tissue is returning to the normal state, the crepitating sounds can again be heard. The disease may

involve one lung or part of both. The chances for recovery are better in lean than in fat hogs, as the disease is usually less severe. The attack runs a course of from ten days to two or three weeks.

Treatment.—The hog should be given a comfortable pen and kept as quiet as possible. If it will eat, a light sloppy diet should be fed. To keep the bowels loose, from one to three ounces of castor oil can be administered occasionally. As a counter-irritant to the sides of the chest the following liniment can be used; oil of turpentine ten parts, croton oil one part. If the heart action is weak, from five to ten drops of tincture of digitalis should be given every three or four hours. During the colvalescent stge, if the animal appears weak, alcoholic stimulents can be given.

PLEURISY.

This is an inflammation of the membrane lining the chest cavity and covering the lungs.

Causes.—Pleurisy may develop during the course of pneumonia. Sudden chilling of the body, especially if overheated, exposure to cold and damp pens are common causes. It may occur in the different contagious diseases (hog cholera, swine plague, and tuberculosis).

Symptoms.—The early symptom of the disease is chilling. Sometimes the hog is lame in one or the other of the fore legs and appears stiff when it walks. The appetite is poor and the hog is restless or lies down most of the time. The breathing is highly characteristic. The ribs are held rigid and the respirations are short and jerky, the movement being noticed mostly in the flank. The body temperature is higher than normal, the pulse quickened and the cough rather surpressed. Pain is a very prominent symptom. When the sides of the chest are pressed upon with the hand the hog will flinch, sometimes grunt or squeal. On auscultation friction sounds are heard. In case there is an outpouring of fluid into the chest cavity (hydrothorax) these sounds are not heard and all respiratory sounds toward the lower part of the chest are deadened. If much fluid accumulates in the chest cavity, the symptoms of pain are diminished, but the respirations are more labored and the pulse weaker. Toward the later stage of the disease, the hog is greatly depressed. When made to get up, it may squeal. Frequently, it is seen lying on its side as though it

were dead. The course of the disease is from one to two weeks. In mild cases and when only a part of the pleura is involved the symptoms are less severe.

Treatment.—Good care at the beginning of the attack will help in aborting it. The hog should be placed in a warm, clean pen and made as comfortable as possible. In a warm pen and when the hog is quiet, warm packs can be applied to the sides of the chest and the hog covered with a blanket. The medicinal treatment does not differ greatly from that recommended in pneumonia. A teaspoonful of syrup of squills and from three to six drops of tincture of aconite can be given three times daily. Sulphate of quinine, five to twenty grains, and nitrate of potassium, ten or fifteen grains, can be given every four hours. The same blistering liniment as recommended in pneumonia can be applied to the walls of the chest. It is best to administer a physic early in the attack, and feed the hog a light sloppy diet.

DISEASES OF THE HEART.

Diseases of the heart are not uncommon in the hog. Inflammation of the lining membrane (endodcarditis) and the covering of the heart (pericarditis), and sometimes inflammation of the heart muscles is met with in pleurisy, pneumonia, rheumatism, hog cholera, swine plague and other diseases.

Symptoms.—These are high temperature, depression, severe pain and palpitation. Occurring as they do as complications of some other disease, they are usually over-shadowed by the original disease.

The prognosis is unfavorable.

FATTY DEGENERATION OF THE HEART.

Causes.—Fatty degeneration of the heart is due to overfeeding and lack of exercise. The fat accumulates in masses around the heart and in the muscular tissues, the natural structure being replaced by fatty granules.

Symptoms.—In this disease, the heart action is weak and irregular. The hog is unfit for any kind of exertion and may die suddenly if this is attempted. Palpitation may occur.

Treatment.—The treatment is wholly preventive and consists in avoiding such conditions as may cause the disease.

PALPITATION. SPASM OF THE DIAPHRAGM. THUMPS.

True palpitation is a sudden violent beating of the heart not connected with any structural disease of the organ. It sets in suddenly, the cardiac sounds are louder than normal, the beats are quickened and the animal may be restless and appear anxious. This affection sometimes occurs during the course of some digestive disorder. Excitement and exercise may also cause it.

Spasm of the Diaphragm is quite common in pigs. Digestive disorders, especially overloading of the stomach and lack of exercise, are the main causes. A number of pigs in the litter or in the same pen may become affected at the same time. This is especially true of litters not given sufficient exercise.

Symptoms.—There is a sudden jerking movement of the flank. When the pig is standing quietly, this is very noticeable, and may be of such violence as to move the body backwards and forwards. It may be accompanied by a sound that can be heard some distance. These contractions are not rhythmical, but occur more frequently at one time than at another. After exercise the jerking is violent, and after a full meal, is more pronounced than when the stomach is empty. Thumps interfere with the pig's appetite to a certain extent and they do not thrive, becoming stunted in some cases. Sometimes they lose flesh quite rapidly and become very thin. The course of the disease is from a few days to several weeks.

Treatment.—Exercise alone will generally effect a cure. When the disease develops in a litter, they should be turned on pasture and given plenty of opportunity to run around. If this cannot be done they must be given exercise in some other way, as placing them in a pen or box away from the mother. From three to fifteen drops of of tincture of opium can be administered in a little oil every three or four hours to give relief. It is well to administer a physic of raw linseed oil at the beginning of the trouble.

DISEASES OF THE NERVOUS SYSTEM.

CONGESTION AND ANEMIA OF THE BRAIN.

Causes —In congestion, the blood vessels of the brain become engorged with blood. Fat, plethoric hogs are predisposed to this condition. The exciting causes are sunstroke, exertion, tumors and parasites pressing on the brain, and blows on the head. Congestion may occur as a complication in some of the infectious diseases.

Anemia of the brain is due to an insufficient amount of blood in the brain, and may be caused by a weakness in the heart action or severe hemorrhage.

Symptoms.—These generally come on very suddenly. The hog shows symptoms of excitement and sensitiveness, or appears dull and drowsy. Death may occur in a short time. Apoplexy due to rupture of capillaries in the brain sometimes occurs, and the disease tends to merge into an inflammation of the brain.

Treatment.—Place the hog in a cool place and apply water or ice to the head. Bleeding at the beginning may be followed by good results. As a purgative, four or five ounces of linseed or castor oil can be given. The after treatment consists in keeping the hog quiet and in a cool comfortable place. In anemia of the brain, the medicinal treatment is along the line of stimulants, and cold applications to the head are contra-indrdeated.

ENCEPHALITIS.

Inflammation of the Brain and its Membranes.

Causes.—As causes of this disease can be mentioned high temperature as in summer, unusual exercise, sudden changes in the feed, overfeeding, parasites (cysticercus), unsanitary conditions and injuries to the head. Inflammation of the brain occurs in some infectious diseases. It may follow a congestion of the brain.

Symptoms.—They usually set in abruptly, the hog apparently in perfect health will within a few hours manifest serious symptoms of a nervous character. The disease is usually ushered in by a period of dullness. In some cases, however, the hog appears nervous and excited from the first. During the period of excitement or delerium, the hog champs its

teeth, froths at the mouth, walks or runs about the pen, generally in a circle and without showing much ability to dodge obstructions. It will squeal or grunt, try to climb up on the sides of the pen, press its head against the wall or fence, and finally fall over in a convulsion. It may regain its feet in a short time or lie in a stupor which usually ends in death. The gravity of the disease cannot always be judged by the frequency and violence of the attacks, as often when the hog is sleepy and drowsy from the first, it rapidly proves fatal. The course is usually short and the prognosis unfavorable.

Treatment.—A large dose of salts should be given early in the attack. Bleeding and cold applications to the head prove of some value by lessening blood pressure in the brain. The pen should be dark and cool. When the disease terminates in paralysis, iodide of potassium, twenty grains, and tincture of nux vomica, ten or twenty drops, can be given in a few ounces of water three times a day.

APOPLEXY.

Apoplexy may occur in hogs that are in a very fat condition and is due to a rupture of a bloodvessel in the brain. It sometimes happens as a result of congestion of the brain. When this accident occurs, the hog drops suddenly, becomes unconscious and is usually dead in a short time.

VERTIGO.

Blind Staggers.

Vertigo may be associated with diseases of the brain and its membranes, such as anemia, congestion, tumors and parasites (cysticercus), especially the latter.

Symptoms.—These are attacks of blindness, jerking upward with the head, turning in a circle or rotating on the long axis of the body, running straight ahead and finally falling on the side or rolling over and over. When due to parasites, the hog turns to the side on which the parasite lies and the attacks are apt to occur at any time.

EPILEPSY.

Spasms, Fits.

This disease is characterized by sudden loss of consciousness, convulsive movements, etc. In the intervals between the attacks the hog may appear in good health.

Causes.—Epilepsy may be due to lesions in the spinal cord or brain. It is sometimes transmitted fro mthe parent to the offspring and in-breeding is also thought to cause it. Intestinal worms are probably the most common cause of spasms in young pigs. It may also occur as a result of dentition.

Symptoms.—The pig may be restless previous to the attack. The convulsive contractions generally begin in the muscles of the head and extremities. Jerking of the muscles of the face, champing of the jaws and an unsteady gait is noticed at first. Suddenly the pig falls, consciousness is lost, the limbs are extended and the seat of convulsive movements, the head may be thrown back, saliva runs from the mouth and urine is passed. Because of the respiratory muscles being involved, the animal has great difficulty in breathing. In mild cases the convulsive movements are feeble and may cease in a few seconds. Usually the attack lasts a few minutes. The hog may get up and act as though nothing had happened or act dull and sick for several days. There is some danger of the pig dying in an attack. Sometimes during a seizure, the other hogs in the pen will kill it.

Treatment.—The spasm may be stopped by throwing cold water on the pig's head, or better by immersing its body in warm water. The pig should be kept as quiet as possible between attacks. A cathartic of castor oil should be given. Until the stupor has completely passed, it is best to give from half a dram to a dram of bromide of potassium in the feed or drench twice daily. As soon as it acts well, it can be turned out with the rest of the herd.

CHOREA.

This affection is commonly seen in young pigs, but may develop at any age. The causes of the disease are not definitely known. It is more commonly seen in weak, poorly developed or deformed pigs, specially those

having a bulging forehead and showing a tendency toward hydrocephalus.

Symptoms.—Chorea is characterized by spasmotic movements of some part of the body, as the head, or one or more legs. The head is most often affected, and is jerked to one side and may be accompanied by wry neck. The jerking occurs in quick succession, or there may be considerable interval between jerks. The attacks may become spasmotic, that is, very bad part of the time and only slightly so at other times. The jerking takes place more or less constantly during the waking hours. If a leg be affected, it will be drawn up and put down suddenly, keeping up the motion more or less constantly while standing. There will also be some twitching when lying down and not asleep.

Often when pigs are so affected, although in good condition when the trouble begins, they become thin and puny.

Treatment.—The best treatment is to turn the affected pig out on clover pasture, and give it plenty of milk. As the animal grows, it may gradually get better without medicinal treatment. Good results may follow the administration of tincture of asefoetida in half tablespoonful doses two or three times a day.

SUNSTROKE OR HEATSTROKE.

Hogs, especially fat hogs, when driven on a very hot day, or handled and shipped some distance are apt to be overcome with the heat. If kept in a pasture unprovided with shade, they may suffer severely from the sun.

Symptoms.—The principal symptoms are fatigue, dropping of the ears, staggering gait, sudden collapse and unconsciousness and death. Convulsions may occur and death generally follows in a short time.

Treatment.—The preventive treatment consists in not handling fat hogs during the hottest part of the day in the very warm weather, and providing the hog pasture with some shade. When handling hogs in hot weather, frequent wetting with cold water will help in keeping them cool. If overcome by the heat, it is best to move the hog to a shady place and pour cold water on the head, but not upon the body. As a stimulent, alcohol (one tablespoonful) or tincture of nux vomica (one teaspoonful), can be given in a little water.

PARALYSIS OF THE POSTERIOR PART OF THE BODY.

Causes.—Small centers of inflammation in the spinal cord due to injuries in the region of the back will cause a paralysis of the hind parts. Pressure on the cord from tumors, parasites (cysticercus), or an over fat condition will also cause it. It is not uncommon for paralysis to occur among a number of hogs in a pen or when shipped in cars or in a crate. Lack of exercise, indigestion and constipation are said to cause this condition. This disease is usually called "kidney disease."

Symptoms.—The paralysis may develop suddenly or come on gradually and nearly always involves both hind legs. When the disease develops slowly the first symptom noticed is an unsteady gait, the hind legs do not follow exactly in line with the front ones, become crossed, or instead of walking directly forward, the body appears to go sidewise. After lying down there is more or less difficulty in getting up. These symptoms become progressively worse until the hog simply drags the hind parts. If the paralysis develops suddenly, the pig is found dragging the hind parts and unable to get up on the hind legs. The appetite is usually good in the early stage, and may remain so. Pressure over the affected region does not cause the animal pain, but sometimes it will squeal when moved. The appetite may become poor and the bowels constipated, depending upon the extent of the lesions. If recovery does not take place within a few days or a week, the case is not apt to terminate favorably.

Treatment.—This consists in moving the hog to a comfortable pen where it can not be disturbed and feeding it mostly on slopy food. It is very necessary that no dry feed be given in order to prevent constipation. Early in the disease a cathartic of Epsom salts should be given and repeated if necessary. This may be supplimented with an enema of water and glycerine. From five to ten drops of tincture of nux vomica should be given two or three times a day. Counter-irritation along the back by means of blistering liniments (oil of turpentine ten parts, croton oil one part), or the firing iron can be used. Dr. Peters, of Nebraska, recommends the firing iron. To fire the back of a hog, number sixteen wire can be used. There should be fifteen or sixteen pieces about a foot in length pointed at one end. The pointed end should be placed in a charcoal or corn cob fire and heated to a white heat. When ready for

use, they can be held in a pair of pincers, and the skin punctured at points an inch or two apart in the region of the loins. The wires should be allowed to pass through the skin and into the tissue beneath, or the operation will not give satisfactory results. The hog should not be forced to walk, as this will retard recovery. After the animal is able to walk, kepe it away from other pigs for a few weeks.

DISEASES OF THE GENERATIVE ORGANS.

STERILITY. BARRENNESS.

Sterility may exist in the male or female and may be temporary or permanent. Some years the per cent. of barren sows is very large.The cause for the condition has not been ascertained.

Causes —In the male impotency is sometimes a functional trouble, due to improper development of the sexual organs or a broken copulatory organ. Other causes are a fatty degeneration or infiltration of the testicles, lack of physical or functional exercise and old age.

In the female, sterility may result from a greater variety of conditions than in the male. Excessive fattening, as is sometimes seen in sows fitted for exhibition purposes, will cause it. This may be due to the ovaries becoming so infiltrated with fat as to interfere with their function, or to an occlusion of the passages with fat. In the former case the change is often so great that nothing will insure a complete return to the normal, but in the latter the function can be restored by reducing the condition of the sow. Sometimes a rigid os prevents the entrance of the seminal fluid into the womb. Such a condition may occur in young or aged sows. Inflammation of the lining membrane of the uterus or vagina may also cause it. In this condition a discharge, usually so slight as to escape notice, occurs, and when the male element comes in contact with the abnormal secretions, it is destroyed. In old age barrenness occurs.

Faulty development of the generative organs is not uncommon in sows. The uterus may be abnormally small, the ovaries rudimentary and the vagina and os imperforate. In these cases, the sow may never come in heat and never conceives.

Treatment.—Excessive fat is a frequent cause of sterility in both the male and the female and must be overcome by dieting and exercise. The

male should not be used to excess and should be kept in a healthy, vigorous condition. If the os is rigid and closed, preventing the entrance of the seminal fluid into the womb, it should be dilated. Closure of the maternal passages by fat can be overcome by a proper diet and plenty of exercise.

ABORTION.

Abortion or slipping of pigs is a troublesome problem with which to deal. There seems to be two varieties in these animals, the same as in the other domestic animals, sporadic and infectious. The sporadic form is the variety most often met with and is due to accidents, as slipping, falls, being kicked by a horse, or hooked by a cow, by being run by dogs, or worried by other sows in heat, or by a boar, to spoiled or musty food, to "piling up" in bed, to sudden exposure to cold and to the effects of some other disease, as cholera. It can readily be observed that these causes will not as a rule act upon many sows in the same herd with sufficient violence to cause abortion, as the sow does not abort easily. After an outbreak of cholera we expect a considerable percentage of abortion. While an infectious abortion of the sow has not been described, the Station has been the recipient of several accounts of such trouble that could not be accounts for upon any other hypothesis. In these cases a greater or less percentage of the herd would be affected, and, like barrenness, the trouble is much more frequent some seasons than at others.

Symptoms.—The symptoms of abortion when due to accidental causes are great uneasiness, shivering, making of a bed, violent straining and groaning. The parts are unprepared for the accident and therefore is associated with considerable pain and occupies several hours. If the abortion occurs within the first two months a discharge of blood and a macerated foetus and membrane are all that will be found. 'After two months the foetuses will be entire. In some cases there will be a loss of appetite and an indisposition to move about for a few days, while in others the disturbance is so slight as to be scarcely noticeable. In the infectious form of the disease the genital tract seems to be prepared and there is less disturbance than in normal labor, and unless the swollen genitals and

the expelled foetuses are seen, the first warning of such an accident may be the recurrence of heat. Infectious abortion seems to occur most frequently at the end of the second month.

Treatment.—Very little can be done to arrest the act and without knowing the cause it is hard to prevent. It is a wise measure in all cases to remove abortion sows from the herd upon the assumption that it may be infectious and that the presence of such an animal may be a menace to others.

MAMMITIS. GARGET.

Causes.—Inflammation of the udder may occur in heavy milkers, due to the fact that all of the milk is not drawn. This condition may exist when a part or all of the litter dies. Obstructed teats will sometimes cause it. Following a difficult case of parturition the udder will sometimes become inflamed.

Tumors of the mammary glands.

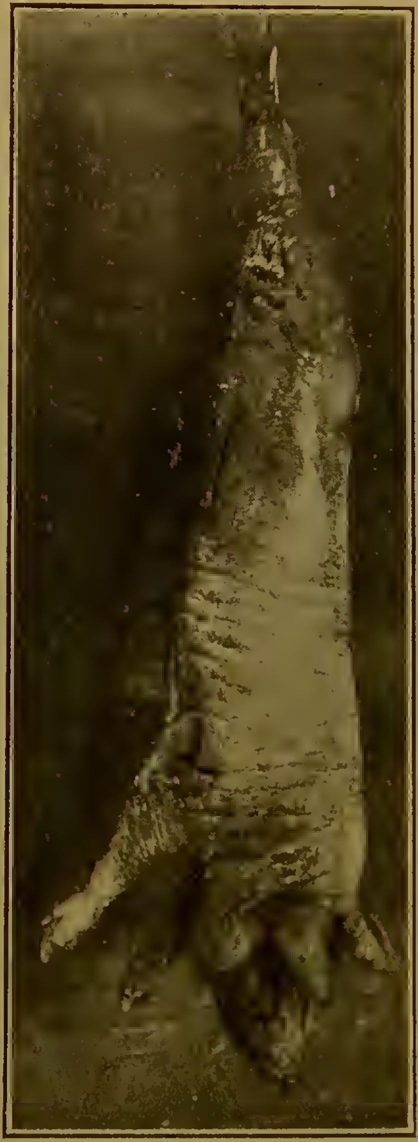
Treatment.—Remove as much milk as possible and bathe the udder with hot water for twenty minutes several time a day. Knead the parts thoroughly. As a local application use a dram each of tincture of belladonna and spirits of camphor in two ounces of lard; rub well when applying it. A cathartic of Epsom salts or castor oil should be given every other day until the condition is relieved. When the teats are sore, they

should be bathed once a day with white lotion (one part zinc sulphate, three-fourths of a part lead acitate, thirty parts water) until healed.

DISEASES OF THE SKIN.

URTICARIA.

Causes.—Unhygienic conditions and irritation to the skin from lice and drugs are frequent causes of urticaria. Young pigs are predisposed to this class of skin diseases, and it may be seen in the different specific diseases, as cholera and swine plague.



Thick, rough skin due to prolonged exposure in a wet cold place.

Symptoms.—The blotches come on the skin very suddenly, usually in the night and appear as red, hot, swollen spots that may run together and become very large. The spots are seen on almost any part of the body. On account of the itching, the hog will scratch and rub the part and the surface may become abraided. In the light cases, the trouble will pass off about the second day without the formation of pustules. In the more severe form, pustules develop and it requires a week or more to make a recovery. The appetite is usually impaired and the hog is feverish. This disease is not contagious.

Treatment.—Two or three ounces of Epsom salts should be given in the feed, and the hogs fed a light sloppy diet. If dirty or lousy, they should be dipped or washed with a watery solution of some of the cresol preparations. In severe cases ten drops of Fowler's solution of arsenic should be given twice daily.

ECZEMA. PITCH MANGE.

Causes.—This disease is associated with unhygenic conditions, filthy pens, extremes of heat and cold, and a debilitated condition. It may also occur in specific diseases (hog cholera, articular rheumatism, etc.). What seems to be a variety of this form of mange, occurs upon marsh land in the summer, when dry, due to the irritation of the soil—itch dirt. This is seen frequently in the Kankakee region.

Symptoms.—The disease starts by small red spots on the skin. These are followed by vesicles (blisters) which in time becomes pustular. Finally these dry up and form thick crusts which gradually wear down and become thin and branny. All stages of the disease may be seen on the skin at the same time. There is intense itching and the hog may have a slight fever, a poor appetite and act dull.

Treatment.—This consists in bettering the hygenic conditions under which the hogs are kept, and either washing or dipping them in a water solution of some of the coal tar preparations. The washing or dipping should be repeated at frequent intervals.

SKIN WARTS.

Warts are simply piled up epidermal cells and are best removed with

a knife. A preparation of a dram of salicylic acid in an ounce of castor oil, rubbed on once or twice a day for a couple of weeks may remove them.

SORE TAILS.

Causes.—The causes of sore tails, and tails dropping off, are cold, filth and injuries. When young the tail may become injured by the mother stepping on it. Sometimes when the pen is filthy bacteria will

Pitch mange due to "itch dirt."

cause it. Old hogs, when allowed to wallow in the mud, may loose a portion of their tails from the mud balls that accumulate toward the ends. Loss of the tail is frequently associated with an unthrifty condition.

Treatment.—This is preventive. If the pens are filthy, they should be cleaned and antiseptics used freely. The loss of the tail is of little consequence to the ordinary hog, but for those used for other purposes or to be sold as breeders, it becomes a blemish.

DISEASES OF THE LOCOMOTORY ORGANS.

ARTICULAR AND MUSCULAR RHEUMATISM.

Articular and muscular rheumatism are so frequently associated in the hog that it is best to discuss them together. Although hogs live under favorable conditions for the development of rheumatism, they do not often develop the disease. This is probably due to the protection afforded by the subcutaneous fat.

Causes.—This disease is attributed to cold, damp pens and exposure, but it may occur in hogs when well managed. Overfeeding is also said to cause it. Rheumatic symptoms are frequently noticed at the beginning of an outbreak of hog cholera.

Symptoms.—The muscles and joints may both be involved and the symptoms quite marked. There may be a fever, loss of appetite and a general lack of condition. The lameness will move about and may involve one or more of the legs. Sometimes there is considerable swelling of the hock, the knee or the joints of the foot. If the muscles of the back are involved, it is arched and very tender on manipulation. Stiffness in the gait is present, especially if the quarters are involved. The pain in the muscles and swollen, inflamed joints is intense, and the hog will sometimes squeal when the parts are handled or the joints flexed. While the hog is asleep there may be sudden contractions, indicating pain due to relaxation of muscles. On account of the pain and difficulty in walking, the hog will lie around the pen most of the time and refuse to go far for his food.

Treatment.—Preventive treatment is very important. It means the providing of dry, comfortable quarters and the avoidance of exposure. The straw stack should be avoided as a shelter for hogs. Sick hogs should

be given sloppy feed. Salicylate of soda can be given in twenty or forty grain doses three times daily. Recovery occurs in from two to three weeks. The disease may become chronic.

RACHITIS, OR RICKETS.

Causes.—This condition is due to a lack of development of the bones. The mineral matter is not deposited in the normal proportion. It is seen in growing pigs after weaning. It most often occurs in those that receive an almost exclusively corn diet with no milk and no pasture. It is seen more often in winter than in summer because the conditions enforce the penning and feeding of the pigs at that season. It is also seen in some litters which might indicate that it was hereditary.

Symptoms.—The disease is characterized by weakness of the bones, bending of the legs, breaking down upon the feet; there may be either a dropping or arching of the back, a spraddling gait, distorted face, bulging forehead, sniffles and paralysis. Such pigs are nearly always fat at the beginning. The disease does not tend to destroy the animal quickly, as it is a slowly progressing disease.

Treatment.—The treatment as far as it can be of service, is to feed less fattening food and substitute milk, oats, rye, and a little oil meal. An abundance of salt,, charcoal, wood ashes and air slaked lime should be available.

SORE FEET.

Causes.—If hogs are kept continually on hard floors or driven over hard, rough roads, the feet may become inflamed and bruised. Standing in filth may cause the feet to become sore, the moisture softening the tissue at the uper margin of the wall, in the interdigital space and at the heel.

Symptoms.—The hog flinches a great deal when it walks, goes quite lame. This is especially true of heavy hogs, and if the pain is severe, they lie down most of the time. On making a local examination, the claws may be found long and over grown or the heels and the space between the claws is swollen, sore and inflamed.

Treatment.—When caused by hard floors, simply turning them out on pasture will effect a cure. If the pens and yards are filthy, they should be changed to clean dry pens, and the feet freed from all filth and washed once a day with a four per cent. watery solution of some of the coal tar preparations; or with chloride of zinc (one teaspoonful to the pint of water). It is very necessary that the hogs be kept in a clean, dry place until well.

SNIFFLES. SNUFFLES. BULLNOSE.

It is evident from the descriptions given that all writers are not agreed upon the nature of this affection. There are two varieties of the affection—the catarrhal and the rachitic.

In the catarrhal form we have a more or less wheezing, respiration occurring at irregular intervals. There is a profuse, watery discharge from the nostrils, causing the animal to blow violently when first getting out of bed or after eating. The animal can not exercise freely owing to the difficult respiration. The attacks, which are mild and of intermittent character at first, become more severe and the condition is persistent. The discharge changes from a thin, water secretion to one containing blood, to thick mucus, and finally yellowish or purulent. Nose bleeding is frequent owing to the violent efforts to clear the nose. There is a cough, the eyes become red and the tears flow, the hair roughens and the whole appearance is "dumpish." There is difficulty in seizing, grinding and swallowing the food, owing to the soreness of the mouth and throat. The trouble runs a course of from one to five weeks and death comes from starvation or asphyxia. Those that recover nearly always remain stunted.

A post-mortem examination of such a case shows the mucous membrane lining the nasal chambers to be greatly thickened, practically blocking the air passages. The turbinates and the septum become so crowded by the uneven pressure that they are deformed. The effect is to produce a blunt, thickened, more or less twisted nose, depending upon the uneven changes in the different bones.

In the rachitic form we have essentially the same changes take place in the nose, and in addition there are changes in the bones in other parts

of the body. The legs become curved and misshapen, and often there is breaking down on the feet. Not infrequently, too, there will be bulging of the bones of the head, as in hydrocephalus.

Causes.—The cause of the trouble is not definitely known. By some all the cases are regarded as being primarily due to a lack of development of the bones in the nose, thus prdisposing to catarrhal trouble. Others consider that the trouble may be catarrhal from the beginning, due to catching cold, and that the changes in the bones are secondary. The writer is of the opinion that some cases belong to one class and some to the other.

The disease is sometimes described as being contagious, but we are not in possession of facts to justify such a statement. It is more probable that the conditions which give rise to the trouble in one pig may also affect others. It is frequently observed to affect all the pigs belonging to one litter, but I have never witnessed the trouble pass from the pigs of one litter to pigs of another. It has also been observed in four successive litters from the same mother, thus showing a hereditary tendency. There were also other evidences of rickets present.

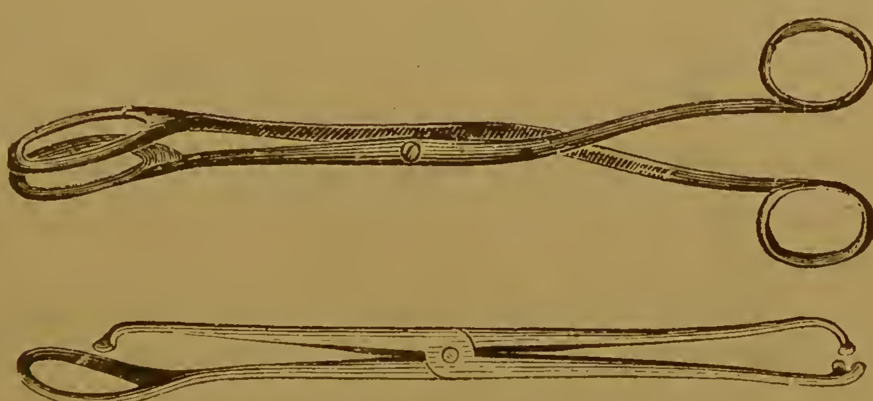
We find this trouble in pigs kept under good hygienic conditions as well as in those that are subject to exposure and poorly nourished, and it is more common in those breeds with stubby, turned-up noses than of the straight variety.

Treatment.—The best treatment is to destroy such pigs. It will end their misery and save expense. The majority will die and those that recover will not be worth feeding in nine cases out of ten. Those who wish to try to save them should put the pigs upon a good pasture and feed sweet milk. Corn should not be given, or, if it be given, there should be oil meal added to balance the ration. If pasture can not be secured, provide a dry, warm pen. Keep the bowels open as the symptoms may indicate. Fumigate with burning tar and apply tar about the feed troughs. An ointment composed of equal parts turpentine, kerosene and ammonia in sufficient lard to make it stiff has been recommended as an application to the face. This is repeated twice a week for a month.

DIFFICULT PARTURITION.

Difficult birth is not as common in the sow as it is in the larger domestic animals. This is because the pelvic cavity through which the foetus passes is large in comparison with the size of the young. A roomy pelvic cavity, however, does not always insure an easy birth, and when stacle to birth, and the tendency on the part of the owner should be not hygiene of pregnant animals, there will be plenty of cases of difficult parturition in the herd.

Causes.—The most common cause of difficult parturition in young, fat sows is a large foetus and a narrow maternal passage, a condition frequently met with when a large male is used on small sows. Other causes are malpresentatioms, monstrosities, and diseases of the foetus (hydrocephalus, emphysemia, etc.). Emphysematous conditions are met with when the act of parturition has been prolonged and the foetus is dead and undergoing decomposition. The only malpresentation met with



The better forms of pig forceps.

is the transverse. In this presentation instead of the head or breech presenting, it is the side, back or belly. In prolonged parturition the maternal passages become dry and the passage of the foetus along them is greatly interferred with. In case of debility and exhaustion, the expelling powers are weak in comparison with the resistance to be overcome, and but little progress is made. A dead foetus acts as an obstacle to a rapid birth.

Treatment.—At the time of birth the sow should be in comfortable quarters where there will be no chance of her being disturbed by other animals, and where the necessary assistance and care can be given with-

out the attendant undergoing too many discomforts. The act of parturition may be prolonged and progress very slowly without their being any obstacle to birth, and the tendency on the part of the owner should be not to meddle too soon, but to wait until nature has had a fair chance. In nearly all cases the sow is quiet and in the recumbent position, and her condition can be judged by the progress made during the labor, and an exploration of the parts with the hand. Before making an exploration, the hands should be washed and the fingers smeared with vaseline. If necessary, the finger nails should be shortrened. When the hand is large and the passages narrow, the fingers are all that can be inserted. This will be sufficient to judge the condition of the maternal passages and the position of the foetus, if it has gotten as far back as the entrance to the pelvic cavity, or into the passages. The explorer should conduct his examination with all the care, attention and gentleness possible, and take time to assure himself of the true state of affairs.

After becoming satisfied as to the conditions present, we should give the required assistance. We should not go too far in assisting her, nor attempt to do what nature herself could not accomplish under more favorable circumstances. For instance, if the foetus is so large or deformed in such a way that it cannot pass through the entrance into the pelvic cavity, we must not attempt it. In case the sow is restless, she should be given a tablespoonful of tincture of opium, and if necessary, the dose should be repeated. If the parts need dilating, fluid extract of belladonna can be smeared on the os. Dry, feverish pasages can be moistened by injecting into them with about an eight ounce syringe, soapy, warm water. The further forward the fluid is thrown, the better will be the results. If the expelling forces are not sufficient to expell the foetus and there is no obstacle to birth, their force can be increased by administering to the sow from half a dram to a dram and a half of extract of ergot and repeating the dose in half an hour if necessary. We must remember, however, that this drug should not be given if there is undue resistance to birth, unless the animal is exhausted and debilitated.

If the difficulty is a malpresentation, it should be corrected with the fingers if the sow is "roomy", or with wire hooks made from number eight wire. The hooks should be crooked about half an inch, rather blunt on the end, and the shank long so that the operator can manipulate them handily. These hooks are useful in helping to extract the foetus, but are

not as handy as some of the many styles of pig forceps now on the market.

After giving the necessary aid, we should wait and watch results. If our efforts have proven unsuccessful, we must then resort to the pig forceps, hooks, etc., and proceed in extracting the foetus. If it has not already entered the pelvic cavity and the passages are narrow, our efforts may prove unsuccessful. This is very apt to be the case if the foetus is emphysematous or dead. The after treatment consists in washing out the uterus and vagina with a two per cent. watery solution of creolin.

CAESARIAN SECTION. LAPAROTOMY.

When all effort to remove the young by ordinary means fail, we can then resort to more heroic measures, that of making an opening into the uterus through the abdominal walls and extracting the foetus. In valuable breeding sows this operation is of special value, but should not be attempted by the stockman. It is useless, however, to operate when the sow is exhausted by two or three days of labor and after the foetuses have begun to decompose.

EVERSION OF THE UTERUS AND VAGINA.

One of the accidents following parturition is the eversion or prolapsus of the vagina and the uterus. Only a portion of the uterus is involved, and it is seldom that a complete prolapsus of this organ occurs. This condition may occur before parturition.

The chief symptom of this accident is the presence of a tumor protruding from between the lips of the vulva, and which may hang some distance below that opening.

Treatment.—It consists in cleaning the organ with warm water and antiseptics and returning it to its proper position. If the part is badly swollen, take a strip of muslin about two yards long and two inches wide; begin winding from the outer end and wind toward the body and allow the bandage to remain on for ten or fifteen minutes. Keep the body end tight and remove the outer part and then rebind in the same manner. After removing the bandage, apply both thumbs to the center of the mass

and return it at once by a slow, steady pressure. The organ can be retained in position by placing a few stout stitches across the lips of the vulva.

INFLAMMATION OF THE UTERUS AND VAGINA.

Causes.—Inflammation of the uterus and vagina may be caused by injuries to the walls of the maternal passages and infection from pathogenic germs, or as a result of the retention of dead foetuses. This latter cause is not at all uncommon.

Symptoms.—These are tumefaction of the vulva, heat and redness of the mucous membrane lining the vagina, fever, straining, loss of appetite and dullness. In serious cases the temperature is high, the respirations quickened, and the animal shows evidence of severe pain. The inflammation may extend from the womb to the lining membrane of the abdomen. There may be a foul smelling discharge from the vagina. When the inflammation becomes chronic, as it often does, the appetite improves but the sow becomes very thin and weak, and the disagreeable discharge from the vagina continues. The prognosis is not favorable; the sow usually dies or is in such condition that it is not profitable to keep her.

Treatment.—Preventive treatment consists in being careful in manipulating the passages when aiding in parturition, and in preventing the infection of the parts by the proper use of antiseptics. The genital canal should be washed out twice daily with a two per cent. solution of creolin. A gallon or more of warm water should be used, and it is best to administer the douch with a fountain syringe. A cathartic can be given if necsesary. If depressed, alcoholic stimulants can be given. Quinine and salicylate of soda, twenty grains of each, and gentian, ten grains, should be given every four hours. This should be kept up until the fever has subsided and the appetite has returned. Nothing but slops should be fed. Tonics, good feed, and good care are very necessary in the chronic form of the disease.

SURGICAL DISEASES.

CHOKING.

Causes.—Choking may be due to sharp objects when swallowed penetrating the mucous membrane lining the pharynx or oesophagus, and at-

tempting to swallow objects (potatoes, roots, etc.) too large to pass down the canal. Paralysis of the oesophagus may sometimes cause it.

Symptoms.—If the choke is complete, the hog is unable to swallow food, salvia dribbles from the mouth and tympanitis may develop. If not relieved, death will occur from suffocation. The animal may get rid of the choke by vomiting. In partial choke there is difficulty in swallowing and salivation. In thin hogs if the object is lodged in the pharynx, it may be felt by pressing the pharynx with the fingers. If the foreign body is lodged in this region, instead of grunting, the hog will make a shrill sound.

Treatment.—When the foreign body is lodged in the pharynx, it may be pushed forward by pressing below it with the fingers, or a blunt flexible stick can be used in dislodging it. Mucilaginous drenches should be given, but drenches must be given carefully, as there is some danger of their getting into the air passages. Unless relieved soon after the accident has occurred, it is best to slaughter the animal.

HERNIA.

Rupture.

Causes.—Hernia is a condition in which a portion of the intestines or omentum have passed through the walls of the abdomen and lie just beneath the skin. Hernia in pigs is due to congenital defects, as an open umbilicus and a wide inguinal canal, and to increased pressure on the walls of the abdomen by the intestines caused by the pigs piling up and lying on each other, and to crawling through a small opening in the pen or fence. Congenital hernia makes its appearance soon after birth.

UMBILICAL HERNIA.

Symptoms.—Umbilical hernia is recognized by the presence of a swelling or tumor below the naval opening. The swelling is soft and free from inflammation, is larger at one time than at another, and by laying the pig on its back and pressing downwards on the swelling, it may disappear. Pigs with umbilical hernias do not thrive as they should and sometimes become stunted.

Treatment.—The treatment of umbilical hernia is not difficult, and is usually followed by good results. The method of operating is as follows. The pig is placed on its back and held there by an assistant, and with the finger the size and the position of the umbilical opening is determined. If the intestines do not pass back into the abdominal cavity of their own accord, they should be pressed back with the fingers. The hernial sack is then held by the assistant and a strong cord tied around its base close up to the abdominal wall. The ligature should be tied tight enough to cut off the circulation in the sack and cause it to slough off. The swelling caused by the ligature is sufficient to close the opening, and in a few weeks it will become obliterated. The simple ligature will answer for a small rupture, but if large, a multiple ligature must be used. The seat of the operation is first washed with an antiseptic wash. A slightly curved needle carrying a heavy linen thread that has been laying in an antiseptic solution is then passed through the base of the sack close up to the abdomen, the thread divided and each half tied separately, or one half can be tied and the needle carrying the other half again passed through and tied. The operation is repeated until the necessary stitches have been taken. In case of adhesions between the walls of the sack and its contents, the hernia cannot be reduced and it will be necessary to cut into the sack and break them down with the fingers, then close the opening by stitching across from muscle to muscle. Strict antiseptic precautions must be observed in performing this operation. The after treatment consists in keeping the pig by itself for a few days and in keeping the part clean.

SCROTAL OR INGUNAL HERNIA.

Symptoms.—This form of hernia occurs only in the male. The testicles lie toward the bottom of the bunch which may be so large that it drags on the ground. Raising the hindparts of the pig will cause the bunch to become smaller. Strangulation of the intestines seldom occurs. When the hernia is large, the pig does not thrive and will become stunted.

Treatment.—To relieve this condition it is necessary to castrate the animal. The pig should be starved the day before being operated on. The

covered operation is the one to be preferred. To remove the pressure from the scrotum, the pig can be hung up by the hind legs or held in this position by an assistant. The scrotum is then washed with an antiseptic wash and an incision made through its walls. The operator must be careful and not cut the covering (tunica vaginalis) of the testicles. The incision should be large enough to allow the testicle and its coverings to be drawn outside the scrotum, and permit the operator to break down with his fingers any adhesions present. A needle carrying a thread is then passed through the tunic and cord as high up as possible, the thread cut close to the needle and the cord and tunic ligated. The ligature should be drawn moderately tight and the cord and tunic cut off about half an inch above it. The ligature should be of strong material and when not in use, it should be kept in a vessel containing an antiseptic solution. The open operation, reducing the hernia, cutting through the coverings of the testicle, removing it and closing the opening the same as in umbilical hernia, can be used. It is best to keep the pig by itself for a few days following the operation.

VENTRAL HERNIA.

Scrotal and umbilical hernia are due to dilation of openings already present, all others caused by a tear or break in the abdominal wall, but not in the skin, are known as ventral herniae.

Causes.—Injuries are the cause of this form of hernia. Lying on one another in the pen, as is the case when they pile up, kicks and collisions with blunt objects are common causes.

Symptoms.—A favorite seat for ventral hernia in hogs is on the inside of the flank, the mass of intestines extending backwards between the hind legs. The size of the swelling varies and presents the same appearance as in other forms of rupture. If caused by a local injury, there is more or less inflammation in the part. This symptom is not noticed in old cases.

Treatment.—Treatment is not as satisfactory as in the other forms. After reducing the hernia an incision is made in the sack, and the opening in the walls of the abdomen closed by sutures the same as in umbilical hernia.

INFLAMMATION OF THE TESTICLES.

Causes.—Inflammation of the testicles in hogs is usually due to external violence, such as blows, kicks, bites from other animals, wound, etc. It may occur as a complication of some other disease.

Symptoms.—The first symptom noticed is a painful swelling of the testicles which may extend to the surrounding parts. The rapidity with which the swelling develops will depend on the acuteness of the inflammation. Sometimes the animal has a fever and abscesses may form. Hydrocele may occur as a complication of the inflammation.

Treatment.—A cathartic of castor oil should be given. Cold or hot water fomentations may be used to keep down the inflammation. Iodide of potassium can be given in the feed three times daily. If an abscess forms, it should be opened and washed out once a day with an antiseptic wash. In some cases it is necessary to castrate the animal. This latter operation must not be postponed too long.

HYDROCELE. HEMATOCELE.

Water in the Scrotum.

Causes.—This condition is due to injuries to the testicles and scrotum, the collection of fluid forming as a result of the inflammation of the covering of the testicles (tunica vaginalis).

Symptoms.—Owing to the large quantity of fluid (serum or blood) that may collect between the layers of the tunic, this condition may resemble a scrotal hernia. The swelling is soft, elastic, painless, and confined mostly to the lower part of the scrotum. The fluctuation of the fluid can be recognized on manipulating the swelling.

Treatment.—This is usually unnecessary, as it does not interfere with the health of the animal or endanger its life. The fluid can be drawn off with an aspirating syringe and tincture of iodine afterwards injected into the part. This operation must be performed under aseptic conditions and should not be attempted by the stockman. The fluid can be removed by castration.

INFLAMMATION OF THE PREPUCE.

Causes.—This disease is seen in barrows, and is caused by the secretions from the lining membrane of the prepuce and dirt accumulating in the prepuce or its side folds. If infected by germs, pus will form and the parts become badly inflamed.

Symptoms.—The prepuce becomes swollen, painful and hot, and there is some difficulty in urinating. Pressure upon the part causes the animal severe pain and a disagreeable smelling material may escape. The contents are usually of a cheesy character.

Treatment.—Before treating the animal, it is necessary to place it on its back, and hold it as quiet as possible. The outside of the prepuce should be fomented with warm water, and the inside of the pouch washed with a two per cent. water solution of any of the coal tar preparations. If it is not possible to remove the collection in this way, an incision should be made in both sides of the pouch. All the material must be removed and the part thoroughly washed.

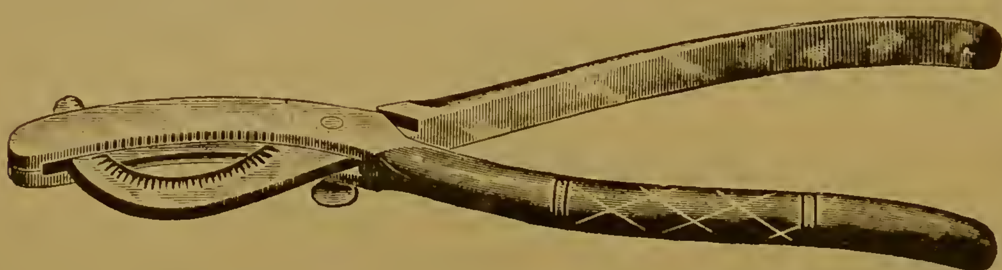
CASTRATION OF YOUNG PIGS.

The age at which castration in young pigs can best be performed is not fully agreed upon. It may be performed when the pig is a few weeks old and still nursing, or after it has been weaned, and when several months of age. Young pigs when nursing the mother do not suffer from the shock of the operation as much as at the time of weaning or when older, and the growth is not noticeably checked. Castration at all seasons of the year and under all sorts of conditions, is practiced, but where the conditions cannot be controlled after the operation, the most favorable seasons for operating are the spring and fall.

Sucking pigs need not be prepared for the operation. In older ones, it is best to starve them for about twelve hours before castrating them, and we should avoid getting the hogs warmed up, as will happen if we have to run them about in order to catch them. This can be avoided if the pigs are shut up in a small pen where the assistant can catch them quickly. One person will be able to confine the pigs for the operation. If the pig is small, the hind legs can be held with the hands and the

head and fore legs between the knees; or it can be laid on its side or back and the hind legs drawn well forward.

The operation is very simple. The operator should provide himself with plenty of antiseptic solution. It is best to wash the scrotum with a two per cent. solution of some coal tar product, and the knife, needles, ligature, etc., should be placed in a similar solution when not in use in order to prevent infection. The testicle is grasped between the thumb and fingers and pushed against the walls of the scrotum. An incision is made in the scrotum and tunic of the testicle parallel to the middle line or raphe, and from half an inch to an inch to one side. The incision should be made with one stroke of the knife and large enough to allow the testicle to slip out. In young pigs the cord of the testicle may be broken off and removed at one jerk. In older ones it can be severed by cutting and scraping with a dull knife. The opposite testicle is then removed in



The emasculator. The best instrument for castrating old and young.

a similar manner. Before liberating the pig, the incisions in the scrotum should be examined and if they do not extend to the very lowest part of the scrotum, they must be enlarged. This will allow the blood and pus to drain off instead of collecting in the part. The wound requires no after treatment. The pig should not be allowed to wallow in ponds or remain in dirty, dusty or muddy pens.

The operation in the boar with the excepting of severing the testicular cord is the same. The cord in old hogs is large and a dangerous hemorrhage may occur if cut off with a sharp knife. Scraping the cord in two with a dull knife, if properly performed, will so crush the blood vessels that little bleeding occurs. Another method sometimes used is ligating it before cutting it off. The best instrument to use is the emasculator. This instrument will so crush the ends of the blood vessels that no hemorrhage follows the operation.

COMPLICATIONS FOLLOWING CASTRATION.

This operation is not free from complications. Observations have proven that they are more common when the work is done carelessly, and no attention paid to antiseptic precautions, than if the proper care and antiseptic precautions are observed.

Hernia is a rare complication of castration, but may be caused by jerking the cord too hard when breaking it off, or from an injury to the pig while handling it. When operating we should be prepared to treat all cases of hernia, whether present at the time of the operation or resulting from it. The covered operation should be used for scrotal hernia.

Hemorrhage is not a dangerous complication in pigs. In old hogs it will occur if precautions are not taken against it. Excessive bleeding can be stopped by picking up the stump of the cord and ligating it. Packing the scrotum with clean cotton and suturing the incision in its walls, may stop it. The cotton should be left in the scrotum for at least a day.

Tumor formation in the scrotum is a common complication following castration. These tumors are sometimes enormous in proportion to the size of the pig and grow rapidly. If large, the pig does not thrive and becomes stunted. It differs from scrotal hernia and hydrocele in that it is very hard.

The causes are infection of the parts with germs, either at the time of operating or following it, and leaving the stump of the cord too long.

The treatment is to dissect the tumor out. This method of treatment will not be successful unless all the growth is removed. The operation is quite painful and frequently the pig dies as a result of it. If the tumor is small and the operation skilfully performed, the results are usually good.

CASTRATION OF CRIPTORCHIDS OR "ORIGINALS."

In "original" pigs the testicles fail to make their appearance by descending through the inguinal canal into the scrotum. Usually but one testicle fails to descend into the bag. It may be found in any part of the abdominal cavity, but in most cases is situated in the region of the flank.

The animal should be prepared for the operation by starving it for about twelve hours. The operator's hands must be clean and the antiseptic solutions and instruments gotten ready the same as in castrating a straight pig. The pig is laid on its side upon the floor or a board, the hind parts slightly elevated, and held there by an assistant. The operator stands at the back and clips the hair from the flank. An incision is made high up in the flank and midway between the point of the hip and the last rib, and large enough to introduce the fingers, or if necessary, the hand. When the testicle is found it is cut off with the emasculator, or the cord ligated and then cut. The incision in the walls of the abdomen is closed with sutures placed about an inch apart. The hog should be kept by itself and the stitches removed in eight or ten days.

SPAYING.

Spaying is performed for the same reason as castration, and, while it was practiced quite generally twenty years ago, it is seldom done now. The necessity for the operation has passed away. It is an operation that is profitable where sows are to be kept until a year or more of age. Under the present method of marketing at eight and nine months it is more profitable to permit the sows to advance to one or two months' pregnancy rather than spay and lose a short time in checked growth, and run the risk of a little loss.

When it is decided to spay, the pigs are prepared for the operation as for castration. They should be three months old and weight from thirty to sixty pounds. The pig is caught and held by two men, upon an inclined board, the head being lowest. The operator stands at the back and clips the hair from the flank over a space about two inches wide and three inches long. An incision is made about midway between the point of the hip and last rib and an inch below the points of the lumbar vetrebrae. The incision should be just sufficiently large to admit the finger. The forefinger of the left hand is introduced and follows the back. The ovaries will be found almost directly downward, suspended by a short ligament. They will feel like a raspberry or blackberry and can be mistaken for nothing else. If the ovary can not be found at once, pass the finger backward toward the bladder and search for the uterus (pig bed) and follow it forward to its termination at the ovary. Remove the ovary by tearing

it off with the the finger or cutting it off with dull scissors. The lower ovary may be removed through the same opening. Close the outside wound with two stitches, using silk thread or silk fishing line.

The operation may be performed througn the middle line of the belly, the same as in spaying the bitch. The method is to hang the pig up by a gambrel with a loop for each hock, make the incision about two inches in front of the pubis and remove the ovaries as already indicated. This opening is closed by two sets of stitches, one in the deep muscles and a second in the skin. One of the objections to this method is the danger of small herniae.

In either method the part should be prepared by washing with carbolic acid and the hands and instruments should be clean. The loss from operating is slight.

PROLAPSE OF THE ANUS.

Causes.—Permanent protrusion of the mucous membrane lining the rectum through the anal opening is called prolapse of the anus. The cause is violent straining from constipation, diarrhea, or anything that will bring about a weakening of the spincter muscle of the anus. Sometimes it is seen among breeding sows, due to their eating cinders and pieces of wood, and the consequent constipated condition of the bowels.

Symptoms.—In some cases only a few folds of the mucous membrane appear behind the anus, in others forms a fair sized tumor rather hemispherical in shape, red and slightly painful. When exposed to the air for a time, it becomes swollen and darker in color, and finely become dry and the surface cracked. In time it will slough off.

Treatment.—Before replacing the prolapsed tissues, the mucous membrane should be bathed with warm water for a few minutes in order to reduce the inflammation and clean it. The protruded portion can be replaced by pressing on it with the finger. If caused by constipation a laxative of castor oil should be given and soft food fed the animal. Sometimes the prolapse will again occur and need to be replaced. If badly swollen, it is best to bathe it with an astringent solution (five per cent. alum solution). To retain it, a stitch can be taken across the anal opening. If the protruded part becomes injured or sloughs, it can be cut off and the margin of the bowel sewed to the margin of the anus.

INFECTIOUS AND CONTAGIOUS DISEASES.

HOG CHOLERA AND SWINE PLAGUE.

When and where hog cholera had its origin no one will ever be able to positively determine. It is not an old disease in the sense of having been known and described for a long time, like glanders or anthrax. Neither is it such a new disease as some would have us believe. The oft-repeated assertion of old farmers that twenty-five or thirty years ago the disease was unknown is merely evidence that the disease was not so generally distributed throughout the country. According to earlier investigations, outbreaks of disease occurred in Ohio in 1833, again in South Carolina in 1837, in Georgia in 1838, and in Alabama, Florida, Illinois and Indiana in 1840 that are believed to have been cholera. As close observations were not made or records kept upon stock diseases at that time, no doubt many outbreaks escaped unrecorded.

It is not known from whence the disease came; some writers claim that it was introduced into this country by the importation of hogs from England, while others hold that the germs are native to our soil and only need a favorable opportunity to produce the disease, the same as in black leg.

Hog cholera seems to have been introduced into this State from Ohio by the driving of hogs to the southeastern and southern counties for the purpose of fattening. At first the disease was confined to a narrow tract along the Ohio River, but the disease gradually spread northward and westward until it reached Terre Haute in 1847 and 1848. The first agricultural report, published in 1859 and 1860, contains a most interesting article upon this disease and dwells upon the heavy losses sustained in the southern part of the State. The history of the spread of this disease —following the lines of commerce—is strong evidence that it is not one indigenous to our soil. Every county has now been invaded and some of them very frequently, so that it may be said that we now have a general infection.

LOSSES.

The total loss to the swine industry in the United States has been variously estimated at from $10,000,000 to $25,000,000 annually, but there can be no doubt that in some years the loss greatly exceeds the latter figure. In 1896 it is probable that the loss was between $45,000,000 and $50,000-000. The annual losses vary between $1,250,000 and $5,000,000 in our own State.

According to the Bureau of Statistics the losses in the different years have been as follows:

Year.	Number.
1883	288,286
1884	351,156
1885	326,555
1886	402,164
1887	512,692
1888	326,359
1889	247,114
1890	256,991
1895	278,143
1896	580,267
1897	899,457
1898	372,868
1899	553,930
1901	236,870
1902	197,491
1903	295,672

The average loss for the sixteen years has been 415,076, having a value of more than $2,000,000. This loss will not be reduced to any appreciable degree in the near future. We know more about the cause of the disease, more about the disease itself, more about its relation to sanitary surroundings, but we do not know more about treatment nor much more about practical preventive measures than was known ten years ago. There is no doubt but that proper sanitary surroundings, pure food and water will do much to avert the losses, but these conditions will not be provided except by the few who appreciate the advantage of pre-

venting loss. Moreover, these diseases can not be wholly prevented by the best hygienic measures that can be provided, which tends to discourage those who do try, and makes others more negligent. Knowing about hog cholera is like knowing about the grip—it does not follow that we can control all the conditions that distribute the germs of disease.

TWO DISEASES.

Hog cholera and swine plague have been made the subjects of special investigation by the United States Bureau of Animal Industry and the greater part of our knowledge of these diseases comes through this source. There is also much credit due to numerous individuals who have studied these affections. Hog cholera has been known for a long time and is recognized as being identical with the disease called swine fever in England. Swine plague was not recognized until about 1890. These two diseases are the cause of practically all of our great losses among swine. In some outbreaks it is easy to distinguish which is present and in others the two affections may exist in the same herd.

There is a specific germ for each of these diseases. Hog cholera is caused by the germ or bacillus of hog cholera and swine plague by the germ or bacillus of swine plague. These germs differ in size, shape, activity, method of growth, resistance to external conditions, and in their effects upon the body. These differences are recognized by those working with the disease, but of course can not be seen without the special equipment found in laboratories. These differences may be briefly stated as follows:

The hog cholera bacillus is a small plant about 1-25,000 to 1-15,000 of an inch long.

The swine plague bacillus is only about one-half of this size.

The hog cholera bacillus is shaped like a short cylinder, rounded at each end, and has a number of delicate projections from the sides and ends like hairs.

The swine plague germ is oval and smooth.

The hog cholera germs have distinct movement.

The swine plague germs have no movement.

The hog cholera germs stain uniformily.

The swine plague germs will stain only at each end.

Hog cholera germs will live in the soil from two to three months.

Swine plague germs will live from four to six days.

Hog cholera germs will live in water from two to four months.

Swine plague germs live only from ten to fifteen days.

When hogs are fed upon cholera germs they will become diseased.

When hogs are fed upon swine plague germs they do not contract disease.

When hogs are inoculated with cholera germs the disease affects the intestines.

When hogs are inoculated with swine plague germs the lungs are affected.

There are other differences between these germs, but those enumerated should be sufficient to satisfy the general reader. The cause of hog cholera is always the bacillus of hog cholera and of swine plague the bacillus of swine plague, and no case of either of these diseases occurs without the germ being present. Other causes may produce diseases with similar symptoms and may thus be mistaken for these diseases. Other causes may so weaken the system as to make the animal easily susceptible to these diseases or external conditions may be favorable for the distribution of the germs. These are secondary causes, but are of great importance.

THE EFFECT OF THE GERMS UPON THE BODY.

Hog Cholera.—The germs of hog cholera are found in the blood and in the internal organs. They grow in bunches and as they are carried along in the blood stream to the small arteries and capillaries they act as little plugs to shut off the circulation in the part supplied by the little vessel. At each place the circulation is thus arrested we have a small red blotch, so frequently seen in the skin, meat, fat, and viscera of hogs that die of cholera. These blotches are so characteristic that meat inspectors have no difficulty in detecting cholera carcasses while hanging upon the gambrel. Another characteristic is that these blotches become redder the longer the time after death, while blotches from other causes become paler.

The spleen or milt, as it is commonly called, becomes enlarged, softened and filled with dark blood.

The intestine is the seat of more or less inflammatory change, particularly in the Peyerian patches and along the lymph tracts. The caecum is especially liable to these changes. In all cases in which the disease

Ulcers in the intestine, in cholera.

continues for some days there is ulceration. The ulcers may be small like a millet seed or be as large as a dime. They may be irregular, as in cases in which they follow the lymph spaces. The edge of the ulcer pro-

jects above the surrounding mucous membrane. The appearance of the surface may be yellowish, reddish, or brownish. The edges are not clean-cut, but are granular. The ulcer may be only in the mucous coat or in the mucous and muscular, but it is rarely perforating. Hemorrhages sometimes occur as a result of invading an artery or vein. The lymphatic glands along the intestine are always red and swollen and those in other parts are enlarged. The contents of the intestine are nearly always black and tarry and have a very foul odor. In some cases the hog will have eaten clay or other earth, causing very hard, dry faeces. The stomach is not often seriously affected. The lungs are either not affected or only secondarily. They usually collapse at death.

Swine Plague.—In swine plague the germs are more diffused through the circulation, but may cause the same red patches.The parts attacked are the lungs primarily, and other organs as complications. The effect in the lungs is to cause bronchitis and pneumonia. The mucous membrane becomes congested and thickened, blocking certain areas, and sepsis or pus formation occurs, making abscess cavities of greater or less size. These pneumonic areas may be small and numerous or a few and quite large. If the hog should die early in the disease the appearance will be that of pneumonia, but if late these abscesses will have formed and they will contain pus or cheesy material. The other organs are involved secondarily.

It will therefore be seen that hog cholera affects the intestines primarily and that the disease may extend to the lungs, and that swine plague begins with the respiratory organs and progresses toward the intestines. Both diseases may be present in the same subject and the lesions are not always typical and a diagnosis can not be made by the eye alone. This is recognized by the inspectors of the meat inspection service and now all cases are reported as hog cholera, while formerly they divided them.

THE LIFE OF THE GERMS OUTSIDE OF THE BODY.

The general behavior and effects of the germs inside of the body are fairly well known, but the history of the germ outside of the body still remains to be determined. The experiments which have been made with the hog cholera germ have not shown it to be able to live for more than

a few months in soil or water, and the results of the work with the swine plague germ have indicated that it can only live about half as long. The results of these experiments are at variance with the experience of any one who has had much field work to do. It is not an uncommon occurrence to have an outbreak of hog cholera follow the turning of hogs upon a field where others had sickened, died and been buried a year prior. Such a result often occurs after hogs have rooted out and eaten parts of carcasses that have been buried for a long time. The writer saw a typical outbreak of cholera follow the turning of hogs into an old house where others had sickened and died three years prior. After the first herd had died the doorways were blocked with rails and no stock had access to the place until three years later. The bedding had never been removed and in two weeks after use by the second herd, thirty out of thirty-six hogs were sick, and it was the only outbreak in that vicinity. People have related many cases similar to the above, the period sometimes being longer and at other times being shorter. Again we may note the turning of fresh hogs into a pen where dead hogs have just been removed and no disease follow. We can not explain all these apparently inconsistent cases upon the evidence from our experimental data.

The germs of some diseases, as glanders, can live for only a short time outside of the body, and hence can only be conveyed by close contact or by animals being placed in the stalls or pens where other cases of the disease have been. Such diseases can be stamped out by slaughter and rigid quarantine. Hog cholera and swine plague do not belong to that class of diseases. In other diseases of which anthrax is a type, the germs can live and multiply outside of the body for a long time and be able to produce the disease when a favorable opportunity arises. Anthrax has been known to occur as a result of eating the forage from the graves of former victims. There are observations which seem to show that the germs must have lived in the ground for at least seventeen years. The experiments with the hog cholera germs do not show them to possess the same resistive qualities attributed to anthrax, but there are many who do believe that they have a very similar life history in nature. If such be the case then the problem of how to control the malady becomes all the more difficult.

SIMILARITY TO TYPHOID IN THHE HUMAN SUBJECT.

Our present knowledge of the germ tends to show that in many respects its life history is like that of the typhoid fever germ. No one would claim that the diseases are identical or that typhoid is as virulent or contagious as hog cholera, but there are points of resemblance. The lesions in the intestines, lymphatic glands and spleen, in the two diseases, are so much alike that cholera is often called pig typhoid. When blood from a typhoid patient is placed in a culture of typhoid germs it causes them to cling together. When blood from a cholera hog is placed in a culture of cholera germs it causes a similar reaction. Typhoid germs are rarely ever found outside of the body and stools of a sick patient, but it is well established that most epidemics have their origin in the water supply. Epidemics of typhoid fever occur in cities, and no matter what may be the source of the water supply—river, lake or wells—it will be found that it is polluted with the discharges from people. Typhoid fever can always be arrested by securing pure water. The researches of the Indiana Experimental Station have demonstrated that cholera is also water borne. In a series of townships in this State it was found that from 33 to 200 per cent. more hogs were lost along the rivers and streams than at a distance from three to ten miles away from the stream. This could be attributed to the more general use of surface water. No such conclusion must be reached that the disease is only water borne, for we have seen the disease pass up the river as well as down and the pigs in a whole section of the country, from one to three miles wide, and from five to seven miles long, become affected simultaneously after a rain.

Less is known concerning the life history of the germs of swine plague than of those of hog cholera; its spread is less liable to be influenced by hygenic measures and it seems to be air borne. Germs very much like the swine plague bacillus have been found in the lungs of other animals. If upon further investigation they should be found to be the same, it will add to our knowledge of the nature of the affection and make us less ready to claim that the disease can be eradicated by sanitary measures.

THE WAYS BY WHICH THE GERMS ENTER THE BODY.

Experiments have been conducted to determine how the germs find their way into the body to cause disease. Hogs fed upon the carcasses of animals affected with cholera develop a virulent form of the disease in a short time. The intestines become the seat of typical lesions, while other parts are not seriously affected. If the germs be placed upon food or in drinking water, they will produce a like result. These experiments show that if the germs be ingested with the food or water, they will develop and produce the disease.

The germs have been sprayed in the air and the hogs made to inhale them, also injected into the windpipe, but the disease did not develop, which may be taken to indicate that in nature the disease germs do not find a point for development in the lungs, or at any rate not as a primary focus.

The germs have been inoculated beneath the skin, but it is only when very large numbers are used that disease occurs. This would seem to indicate that the hog does not contract the disease from inoculation as by the bite of the louse and injuries.

A similar line of experiments conducted with swine plague shows that it does not cause trouble when swallowed, but does do so easily when made to inhale air containing the germs or when germs are injected into the windpipe. The lungs are the primary seat of the affection, and thus differs from hog cholera. Inoculation experiments, both subcutaneous and intravenous, require such large numbers of germs that it would seem that natural inoculation by the louse bite could hardly prove fatal.

The conclusions from these experiments are that in nature, cholera is caused by the ingestion of the germs with the food or water, and swine plague by inhalation.

ACCESSORY CAUSES.

We consider all those factors which lower the resistance of the animal or which disseminate or propagate the germs as being accessory causes.

Among the causes which tend to lower resistance, we may consider feeding, shelter and breeding. The disease is often attributed to the

feeding of green corn, too much corn, etc. In 1896, the Iowa Weather Bureau published a map showing the distribution of the disease in the State. It was found that the greatest losses were sustained in those counties where corn constituted an almost exclusive diet. The lowest death rate was sustained in those countries in which dairying was an important industry and milk was largely used as feed. This was taken as confirmatory evidence of the bad influence of a corn diet. In 1897, the statistics showed that the losses were just the reverse from those in 1896; that the pigs fed upon corn suffered least. This disproved the conclusion of the previous year. As farmers feed in essentially the same way each year, it would be but rational to expect that the losses would be about the same if the feed was a causative factor. Neither is the sudden changing of feed a causative factor, as we have not yet had a single report of an outbreak of cholera at any experiment station as a result of a sudden and radical change of feed. The feeding of green corn or all corn can not be considered a wise health measure. When green corn is fed it should be with the same precautions as in the feeding of cattle—beginning gradually with old corn and increasing the quantity as the pig is able to stand it. This will avoid the diarrhea and intestinal irritation which prepares the way for the cholera germ. Any injudicious management in any kind of feeding will have the same effect. The hog needs a variety of food for strength and health and those best prepared to furnish it will probably fare best.

The hog needs some shelter; it need not be elaborate, something to break the scorching sun or beating storm, to have dry quarters in which to sleep and a clean floor from which to eat. The strawstack is the poorest shelter that can be provided, as it furnishes a place in which to pile up and be buried, overheated when lying down and makes a fit victim for cold. The hog does not need much bedding. A tight wooden floor upon which to feed is rapidly growing in favor from economical considerations, and will become equally as popular from the health standpoint when its value becomes better understood.

The breed of the hog makes no difference to the cholera germ. The objection often made by the farmer that pure-bred hogs are less resistive to disease is not well founded in fact. The razor-back, with digestive powers equal to any task that may be imposed upon them, will succumb

to the diseases the same as the finely bred Berkshire or Poland-China. No breed of hogs is immune to the disease, and the advice to cross our better bred swine with the southern hog is ill founded. All the advantage which they possess is in the fact that they are not so fat and all the vigor that will prevail against the disease can be obtained by using care in the handling of the improved breeds.

Among the agencies which may carry the germs are streams, wind, birds, dogs, people passing from one farm to another, buying hogs from infected herds, shipping hogs in unclean cars, exhibiting at fairs, etc. Some of these means are not within our control, but many of them are, and a proper understanding of them should lead us to prevent thousands of cases.

The germs of the disease may be carried from one place to another by birds of carrion. It is a common experience with farmers that hogs can not be raised upon a farm where there is a buzzard roost. I have learned of isolated outbreaks of the disease occurring from buzzards alighting to eat the carcass of a colt or other animal, and soon after the hogs gain access to the same place and contract the disease.

Dogs prowling about at night carry pieces of dead animals for a mile or more, across pasture fields, feed lots, leaving pieces here and there to be devoured by some unfortunate animal.

Men may carry the disease from place to place upon their boots, or particles of dirt remain upon the wagon wheel, and when dry, drop off in another lot. It should be a general rule never to allow agents for hog cholera cures to come near a pig lot where there are healthy hogs. They go about diseased hogs and do not use the precautions necessary to prevent the spread of infection.

Under some circumstances, I believe the wind may be the bearer of germs. If the germs be distributed along a public highway by the rendering wagon and become mixed with the dust it is possible and altogether probable that they may be blown on the pasture or on the feed lot and thus convey disease. I have seen a few outbreaks continue in one direction for several days after a constant prevailing wind from the southwest. The evidence in this case seemed to point to the wind as the distributing agent. In such cases the germs fall in the water or are taken in with the food.

WATER SUPPLY.

Undoubtedly a very important agency in the distribution of the disease are the streams and surface water supplies. This relationship was under investigation for a number of years. In 1895 the 60 townships bordering upon the Wabash, from Cass County to its mouth, show a loss of 150 head out of every 1,000 produced; 47 townships in the second tier removed from the river show a loss of 100 head per 1,000, or 50 per cent. more loss in the first tier than in the second tier. In 1896 the bordering townships lost 294 hogs per 1,000, the second tier 205 and the third tier 160. In other words, the loss was 34.4 per cent. more in the first tier than in the second tier, and 83.8 per cent. more than in the third tier.

In 1895, 44 townships bordering upon the north fork of the White River lost 138 hogs per 1,000, and 42 townships in the second tier 65 hogs per 1,000, or 112 per cent, greater loss in the townships bordering upon the river than in those a few miles removed. In 1896, the loss in the first tier was 231 per 1,000, in the second tier 156, and in the third tier 75, or 48 per cent. greater loss in the first than in the second, and 208 per cent. greater than in the third. In 1896, 44 townships bordering upon the south fork of the White River lost 200 hogs per 1,000; 58 townships in the second tier lost 150, and 42 townships in the third tier lost 109; thus making 33 per cent. more loss in the first than in the second, and 83 per cent. more loss than in the third. In 1897, the first tier of townships bordering upon the river lost 321 hogs per 1,000, the second tier 182, and the third tier 145; 76 per cent. greater loss in the first than in the second, and 121 per cent. more than in the third.

In every general epidemic of the disease of which I have record in this State the disease has spread from the rivers to the higher land. The evidence furnished by the large number of townships and for successive years should leave no doubt as to the important role which streams and surface water play in the spreading of this disease. If the larger streams are such important factors we can reason that the smaller streams have a like effect. Drs. Salmon and Smith made the following statement in their investigations of the disease. It is pertinent and should be remembered by all swine breeders: "Perhaps the most potent agents in the distribution of hog cholera are streams. They may become infected with the

specific germ when sick animals are permitted to go into them, or when dead animals or any part of them are thrown into water. They may even multiply when the water is contaminated with fecal discharges or other organic matter. Experiments in the laboratory have demonstrated that the hog cholera bacilli may remain alive in water four months. Making all due allowance for external influences and competition with the bacteria in natural water, we are forced to assume that they may live at least a month in streams. This would be long enough to infect every herd along its course."

It is a common practice throughout this State to give the hogs surface water in which to wallow and to drink. Small streams are dammed, drinking places are built into the rivers, a basin is scooped out to receive the water from a barnyard, open ditch, tile drain or spring. All of these afford the best conditions for introducing the germs into the herd. It is not uncommon to go along a public ditch or a stream during an epidemic and find the carcasses of hogs in every stage of decomposition, thus acting as the bearer of infection to new herds. The conditions are better now than ever before, but there are unscrupulous men who will take that means of disposing of their dead, and some one else must suffer.

Some springs afford pure water but many have only a surface origin and are no better than a tile drain. The worst feature connected with the use of a spring as a water supply is the fact that no provision is made for keeping the water clean and pure. The water usually collects in a pool and receives the surface drainage from all the land around and serves as a wallow. Under such circumstances it becomes little better than a pond.

In 1895, the station made an inquiry as to the source of the water supply used by the breeders of pure-bred swine. It was found that in nearly all instances in which they escaped disease, they used well water, Hogs receiving well water do become affected, but when we consider the numerous ways by which the infection can be carried, we are not at all surprised. A good well, however, must always be considered as furnishing the maximum protection.

A study was also made of the relation of rainfall to the disease. No relationship could be traced to the total rainfall for the year or to the total rainfall for any set of months. In general, a season with sufficient rainfall to keep a constant supply of fresh water in the streams or one

of sufficient drought so that the small streams, ponds, etc., become completely dry, are productive of least cholera. A year in which there is much stagnant water is productive of the greatest death rate.

The argument is advanced that the greater loss occurs along the rivers because more corn is raised, more hogs are fattened, and hence they are more crowded. In order to determine this point we divided the counties in the State into groups according to the number of hogs raised per square mile and determined the per cent. of loss for these groups. This is presented in the following tables:

1883-1890.

Number of Hogs Per Square Mile	Number of Counties.	Per cent. of Loss
1- 24	1	8.1
25- 49	7	4.5
50- 74	20	5.9
75- 99	12	9.1
100-124	16	8.3
125-149	11	7.9
150-174	7	8.1
175-199	10	8.8
200-224	8	10.

1895-1897.

1- 24	2	7.7
25- 49	22	9.1
50- 74	18	11.1
75- 99	16	17.9
100-124	12	19.2
125-149	8	17.3
150-174	7	21.6
175-199	4	22.2
200-224	3	26.

During a period of eight years there is comparatively little difference in the losses, but during the period of three years when the disease raged with unusual violence the percentage was much higher in the counties

having a large number of hogs per square mile. It is not possible to tell how much of this increase in loss is due to the greater number of hogs, as it so happens that the counties having a very large number of hogs per square mile and large percentage of loss also have one or more rivers passing through them. From a comparison of counties about equally situated but the number of hogs per square mile very different, I am of the opinion that the number raised is not a very important factor in determining the per cent. of loss.

The season of the year when cholera is most prevalent is always in the late summer and fall. It occurs at all times of the year, but like all the intestinal diseases, as dysentery, typhoid fever, etc., in people, the conditions are more favorable for germ development in the fall.

Hog cholera is often contracted as a result of buying hogs from stockyards for feeding purposes. This is such a common experience that only the strong-headed or uninitiated will be likely to take the risk. The large stockyards and the majority of shipping cars are permanently infected with disease and no matter how healthy the hogs may have been when they started from home, they come in contact with infection and should never be withdrawn from the yards for feeding purposes. We have recorded many outbreaks caused in this way. It has been claimed that the shipping of diseased hogs over the railroad may be the means of causing new outbreaks of disease. I made this a particular object of research in 1895 and 1896, but in no case have I been able to find more cholera along railroad lines than at a distance of a mile or two upon either side. Under the present method of having the right of way fenced, I feel certain that the infection from this source is over-rated.

It would be useless to try to go into detail concerning all the methods by which the disease is distributed. Any means by which the germs are carried from one place to another can be considered an accessory cause. Alll of these means are not under our control, but many are and we will succeed in prevention in the same measure as we eliminate them.

SYMPTOMS.

The diagnosis of the different swine diseases is attended with greater difficulties than the diagnosing of diseases in horses or cattle. Except

upon very careful examination the general symptoms of swine diseases seem to be very much the same. Cholera assumes several different forms and therefore can not be recognized by any specific set of symptoms.

The symptoms vary greatly with the virulence of the outbreak. It may be said to assume an acute form which may run a course in from a few hours to two or five days, a subacute form which runs its course in from five to ten days, and a chronic form which may last a month and more. These are only relative terms and merely used for convenience in describing the disease. The symptoms as here described are for the more common cases that live from five to ten days. About the first symptom to be observed is a general sluggish condition, the eyes more or less closed and dimmed, the ears drop more than usual, and although the hog eats, it is not with that greediness that is customary. The appetite becomes depraved and he will eat the droppings from other hogs or chickens, eat clay and earthy substances. The hog lies about more than usual, hiding in fence corners, under litter, and in out of the way places. During the hottest days he will prefer to lie in the scorching sun rather than in the shade. At first he will respond to calling for feed but later he will not get up unless urged to do so. During the progress of the disease and sometimes from the very beginning there will be pronounced rheumatic symptoms. The hog will be lame first in one leg and then in another. The back will be arched. Diarrhea usually makes its appearance with the onset and is almost always present at some time during the course. The discharges at first are thinner than normal, but they rapidly become tarry and have a characteristic offensive odor. Constipation may occur and is almost sure to do so in those animals that eat earth. In some of the animals the intestinal contents make casts that perfectly occlude the passage and when struck with a board give the sensation of baked clay. Vomiting is also present. There is rapid emaciation. The fever is high and the breathing rapid but not labored.

In the very acute cases, the toxins cause such rapid poisoning of the system that death is so sudden that the symptoms may not be developed. A pig that will be eating at the trough at one hour may be dead the next.

In the chronic type especially, there is likely to be swelling of the ears and cracking of the tail. Both may drop off. The eruption is more pronounced upon the skin. Ulcers may form from the size of a grain

of wheat to the size of the hand. The hair is lost. There is frequently hemorrhage from the nose and sometimes sore mouth and feet. There is coughing as a result of lung involvement.

In hog cholera the great fatality is among the pigs, the older hogs often making a recovery or not being attacked.

In swine plague a cough is probably the first symptom observed. It is paroxysmal at first but is deep seated. This is more noticeable when the animal first gets up or after exercise. Later the cough is more persistent. The breathing is short and rapid with little movement to the ribs and a double jerk in the flanks, like a horse with heaves. The breathing becomes more labored, the throat swells and there is nose bleed. If the hands are pressed over the ribs there will be evidence of pain, often due to pleurisy. The animal will not move more than necessary, the appetite remains better than in cholera, there is much thirst and much less tendency to diarrhea. Constipation is more frequently present than in cholera. The eyes are more inflamed and watery and there is less tendency to skin eruption. Swine plague is particularly liable to attack and be fatal to old hogs. Both diseases may be present in the same herd and even in the same animal at one time, thus complicating the symptoms. In nearly all cases where there is doubt and a number of hogs are similarly affected in the same neighborhood, it is safe to conclude that one or both of these diseases are present.

Hog cholera is sometimes mistaken for other diseases, as worms, diarrhea, or scours, septicemia or blood poisoning, etc. Swine plague is frequently mistaken for pneumonia, pleurisy and bronchitis.

In some places the intestinal worms become so numerous as to cause all the intestinal symptoms ascribed to cholera, vomiting, diarrhea, depraved appetite and emaciation. The onset of the trouble is not so sudden; there is not the same temperature, usually no lameness, and no skin eruption. The worms causing the trouble may be the large intestinal worms, the size of a lead pencil or larger, or the small fellows from one-half to three inches in length. A post-mortem will show the presence of the parasites in great numbers and the intestines will be more or less irritated. The presence of the parasites causes so much loss that some of the cholera cures are nothing but vermifuge powders. The lung worm may also produce symptoms that will be mistaken for swine plague.

Diarrhea, or scours, may also be mistaken for cholera as it is so often induced by a change of feed as turning upon new corn, feeding city slops that contains soap and sour feed. The discharges are usually more fluid and of lighter color than in cholera. The diseases can not be distinguished in the early stages, but a change to a limited dry diet will usually be all that is necessary to bring about the desired result in the diarrheal trouble.

A form of septicemia, or blood poisoning, sometimes attacks a bunch of pigs and being contagious, spreads from one to another. The mouth, nose, lips, tongue, feet or other parts of the body become gangrenous While the disease presents some of the symptoms of cholera, the localization of the trouble is sufficient to make a diagnosis.

Hogs will pile up in bunches when not properly divided and protected during the cold weather, and as a result catch more or less severe colds, resulting in bronchitis, pneumonia and pleurisy, giving rise to symptoms like those of swine plague. The same troubles may also appear as a result of turning hogs upon a stubble or pasture field during very hot weather and then permitting them to have access to cold springs or brooks in which to wallow. These same troubles sometimes arise from the inhalation of dust. A study of the conditions will usually suffice to differentiate the troubles.

TREATMENT.

The treatment naturally divides itself into medicinal, hygenic and preventive. The medicinal is the least important, as we have no specific for the disease. Veterinarians who have made a careful study of the action of drugs and of the character of the disease have tried everything that would seem to be a rational treatment, but have failed. Pathologists have recognized the apparently hopeless condition to be treated and have been unable to suggest a remedy. Experimenters have tried everything which science and empiricism has claimed would cure, but they have found nothing which they could endorse. Notwithstanding all the futile efforts that have been made by careful and conscientious workers, backed by large sums of money and every facility for investigation, we have more than one hundred sure-cure cholera remedies upon

the market in this State. According to the manufacturers (and the claims are all alike), the prevention and cure of hog cholera is a very simple thing and depends wholly upon whether the farmer is willing to buy a few packages of their remedy and use as directed. It is impossible to make a close estimate of the amount paid for such preparations, but it is safe to say that in this State it amounts to more than $100,000 annually.

In 1897 and 1898 the writer devoted considerable time to the investigation of the merits of the various preparations upon the market. Many of these preparations are the product of misguided men, wholly ignorant of the pathology of the disease and equally as ignorant of the action of the ingredients in their concoctions. From a very limited trial they had drawn conclusions and sincerely believed they had discovered a sure cure and were willing to part with it for a large compensation.

A much larger number of the remedies are prepared by men and companies who know the value of a well-worded advertisement and who are in the business for revenue only. They take the formula published by the Bureau of Animal Industry, alter it in some slight particulars, call it by another name and increase the price probably ten times. Another favorite scheme is to take the formula of some of the patented preparations and sell the remedy under a new name, well knowing that if it failed under one name that it would act no better under a new. I was informed that Brown County clay sold for seventy cents per pound.

A third class of remedies are prepared by men who make a study of the disease. They constitute a very small minority.

There is no better evidence that we have no sure remedy than the fact that we have so many upon the market. In these experiments one hundred and fifty-six remedies were tried and nearly 4,200 pounds of drugs. All the formulae given in the patent office reports were filled. A large number of formulae were obtained from the owners and manufacturers, a few by analysis and several hundred pounds of the proprietary remedies were used.

The plan was to test each remedy upon at least five herds in as many places and at different times during the season, in order to work over all the conditions. Without going into details, it may be said that none of them fulfilled their claims. Some were positively injurious. Many of them seemingly did good upon some herds, and if a hurried conclusion

had been reached, it would have been favorable. This is an error too often made and no test can be considered satisfactory that is not used upon a large number of hogs in different herds, in different localities and at different times during the season. The good effects often reported are frequently due to the better care and better hygienic conditions in following the directions. Some manufacturers accompany their goods with carefully compiled directions upon care and management, and as they cost considerable, it insures their being carried out. It must be confessed, however, that directions come high at fifty cents per pound.

Very few remedies find a place upon the market for more than five years. The great majority of them run their course in two years, and the writer is cognizant of but three that have been sold for a period of more than ten years. This is the test of their efficiency. In every instance in which an attempt has been made to take infected hogs from the stockyards, treat them and fatten them for the market, the result has been a failure.

In 1897, Mr. John Cowie, of Iowa, tested a number of the more widely advertised remedies and the results were unfavorable. Dr. Reynolds, State Veterinarian for Minnesota, after examining the matter carefully, issued a circular advising the farmers not to purchase the remedies.

In mild outbreaks and in very many cases much good can be accomplished by such remedies as will keep the bowels clear and act as an alterative and tonic. For this purpose we have a prescription generally known as the government formula, and is as follows:

Wood charcoal, 1 pound.
Sulphur, 2 pounds.
Sodium chloride (salt), 2 pounds.
Sodium bicarbonate (baking soda,) 2 pounds.
Sodium hyposulphite, 2 pounds.
Sodium sulphate (Glauber salts), 1 pound.
Antimony sulphide, 1 pound.

The dose is a tablespoonful for each 200 pounds once or twice a day. It is best given in slop. This costs about ten cents per pound and is the one so much imitated and sold under different names at from twenty to fifty cents per pound.

Our best results in the treatment of mild cases were obtained by using the following:

Chlorate of potash, 1 pound.
Bicarbonate of soda, 1 pound.
Nitrate of potash, 2 pounds.

The dose is the same as in the former prescription. In the early stages and when constipation is present, five grains of calomel are admintered once a day to each 200 pounds of weight, or oil meal is added to the slop.

Another treatment which found considerable favor was a tablespoonful of a saturated solution of chlorate of potash and a like quantity of tincture of muriate of iron once or twice a day for each 300 pounds.

A half gallon of kerosene to a barrel of slop mixed thoroughly gave better results than three-fourths of the remedies tried.

Quinine and salol were also of service.

Carbolic acid and like preparations are disinfectants and not cures.

The treatment of inoculating worn-out horses with cholera germs, killing the horse and feeding it to the hogs was not a success. The feeding of the carcasses of hogs that had died of the disease and then buried is to be condemned. The boiling of the carcasses of cholera hogs and feeding them has likewise disappointed those who have tried it. A final method of prying open the hog's mouth and cutting off the papillae inside of the jaw only abstracts blood.

Recently it has been found that sulphate of copper in very dilute solutions is effective in sterilizing contaminated water. Acting upon this basis, experiments have been made using one to two ounces of copper sulphate to the barrel of water. The results have been above the average to date. The time has been too short to promise anything definite.

PREVENTION BY VACCINATION.

The attempt to prevent hog cholera by vaccination is dependent upon the fact that one attack confers immunity against subsequent attacks. Vaccination has been used against smallpox in the human subject with the most marked success. In this case the pox germ is obtained from the

cow and when vaccination takes place it induces a very mild disease. Vaccination is also used against anthrax in sheep and cattle Here the disease germs have had their vitality reduced by artificial means and only a mild attack follows. The results are highly satisfactory and sheep and cattle are now raised where it was impossible to do so before.

The attempts to vaccinate against cholera have not been successful. In the first place, we know of no animal having a similar disease, the germs of which when inoculated into the hog will confer immunity, and no method of attenuating the germs so that they can be inoculated with safety has yet been discovered. Some years ago Billings and Detmers each thought they had discovered successful means of vaccination and the work was carried on on a large scale. The results were unsatisfactory and had to be given up, as it had the effect at times of starting the disease where it did not previously exist. The work was revived at the Kansas Experiment Station but without great success.

THE ANTI-HOGCHOLERA SERUM.

The serum treatment of hog cholera was probably first demonstrated by Dr. Peters in 1896, and the same work undertaken at almost the same time by the Bureau of Animal Industry. The serum treatment is based upon the same principles as are involved in the anti-toxin for diphtheria.

It is a well established fact that in some bacterial diseases a strong resistance to the growth of bacteria is developed by the formation in the blood of a substance known as anti-toxin. The germs form a toxin or poison and the body forms the anti-toxin to counteract the growth of the germs. If the formation of the anti-toxin is in excess the patient recovers, and it has been found that blood from such a patient can be drawn, the anti-toxin separated, and if added to the blood of a patient that is exposed or affected it will prevent the disease or bring about a recovery. In order to secure anti-toxin in medicinal quantities, it is usual to inoculate animals that do not have the particular disease and produce a slight attack, and after recovery, reinoculate and repeat until the animal can stand an enormous quantity at one time. A quantity of blood is drawn and the serum separated and this is ready for use.

The government has experimented upon a large scale with this treat-

ment and in the main the reports have been very favorable. A number of private firms have attempted the same thing, but up to the present they have not been very successful. This treatment does not promise nearly so much, in the estimation of the writer, as the public has been led to suppose. The serum can not be produced at low cost and its administration requires the service of a veterinarian, two conditions which militate against its general usage.

PREVENTION.

As we have no specific for the disease nor any line of medication that is fairly successful, we must rely upon prevention. This can not be done to the same extent as in many other diseases, and this is especially true of swine plague. To enumerate all of the steps would necessitate repetition of points already made, so that only the more prominent will be considered.

First, the water supply should be from deep tubular wells. Water from a tubular well must come in from the bottom, which means that it has been filtered through the soil and the possibilities of pathogenic organisms being present is reduced to the minimum. Treat all surface water, whether pond, creek, spring or river, as unfit for man or beast. The feed should be pure and wholesome. Slops that have stood and fermented are not better suited to the stomach of the hog than that of some other animal. The dishwater contains so little nutrition that it would be more economical to throw it away than to feed it. Corn is undoubtedly our cheapest fattening food, but should not be given alone to sows and pigs. The addition of a little oil meal or other material rich in protein will be most advantageous. Pasture should be used in season. Hogs are fond of charcoal, ashes and salt, and these seem to furnish something to the body that is decidedly beneficial. The cobs from the feed floor should be raked into a shallow pit and burned to a char and salt added at least once a week. Nearly all prominent breeders follow the practice of supplying charcoal, salt and ashes in some form and many attribute to it the power of preventing disease. A feeding floor should be provided. The bedding for hogs should be like that for other stock—a little at a time and removed often. There is no better reason for com-

pelling a fine sow to lie in her own filth than there would be in the case of a good horse. The bedding of both will become foul and should be removed. It can not be kept pure by disinfectants. Hogs should have no bedding during the warm season, only a dry place in which to sleep.

In case of an outbreak of disease upon the premises, separate the well hogs from the sick and confine all in small lots upon one part of the farm. Separate the well hogs from the sick, as the contagion is spread by the droppings and excreta and the well hogs would be subject to the contagion if kept upon the ground where the sick had been. Formerly the recommendation was made to give the hogs the benefit of a large pasture and keep constantly dividing the herd. Experience has shown that this has the disadvantage of getting the germs scattered all over the farm, prolonging the outbreak, and has no advantage over placing them in two or three small lots. By the latter method the business of hog-raising can again be started as soon as the outbreak is over, using some other part of the farm. Use plenty of disinfectants about the place. Air slaked lime, whitewash, chloride of lime, carbolic acid, etc., are all good. If possible have one man to feed the diseased and another to feed the well hogs. Take advantage of all the sunlight that it is possible to get, as that is the cheapest disinfector.

No rule can be laid down for guidance as to the time when pens, etc., may be used after an outbreak of disease. We have observed instances in which this was done immediately and disease did not follow, and in other cases weeks and months have elapsed and a fresh outbreak would be started. If the place is thoroughly cleaned and disinfected and is well lighted a few weeks will be sufficient, but when it is feasible it is better not to attempt it again during the same season. Experience has shown that a wise precaution is not to permit the hogs to graze or be in pens alongside a public highway. Hogs having the disease and driven to market will leave droppings that become mixed with dust and blown upon the premises. It is the observation of the writer that this is a precaution not sufficiently emphasized.

Hogs may be disposed of in two ways, by burial and burning. If by burial it should be well done, upon a dry place at least three feet deep and in a woods or field to which hogs will not have access for a long time. If it be true than the disease germs live for a long time in the soil then

burial only favors the development of some subsequent and unexplained outbreak. Where burial is practiced, the addition of a quantity of quicklime will be effectual in destroying the germs.

Burning is not difficult when properly done. The essential point is to get at least a foot of wood under the carcass. A very much smaller amount of wood will be required where the fire is under rather than at the side. All carcasses should be disposed of at once and it is far more economical to kill badly infected hogs than to have them linger around for a week or two.

STATE CONTROL.

The argument is often made that the state should exercise some control over hog cholera and swine plague. The precedent is cited that the government stamped out pleuro-pneumonia in cattle and has saved millions of dollars to the cattle interests. The different states take cognizance of glanders and practically have that malady under control. Southern cattle fever is now confined to restricted areas, and sheep are being dipped for scab. The diseases which have been stamped out or brought under control have been of such character as to require close contact to spread them. Hog cholera is a disease of different character and therefore is not amenable to the same methods. Typhoid fever in people sometimes assumes an epidemic character in cities, but by condemning wells and compelling the use of wholesome water the disease can be stamped out. Hog cholera is a water-borne disease and can be prevented in part by securing pure water, but there are other means of spreading the infection. We have little to guide us in what may be accomplished by state control. England has tried to stamp out the disease by preventing the shipment of pigs unless inspected, no hogs to be shipped from a swine fever district, and none to be moved within sixty days from the time of an outbreak. In the shipment of pigs all cars must be disinfected and it becomes the duty of the owner to report every case of the disease as soon as it appears and the animal is slaughtered.

Prior to 1896, the regulations were not so rigid and the effect of the attempt at control may be seen from the following table:

Year.	Outbreaks.	Hogs Slaughtered.
1894	5,682	56,296
1895	6,305	69,931
1896	5,166	79,286
1897	2,155	40,764
1898	2,514	43,756
1899	2,243	30,386
1900	1,940	
1901	3,140	
1902	1,688	
1903	1,478	

The effect has been to greatly reduce the number of outbreaks and also the number of animals slaughtered. For a time the reduction in the number of outbreaks and also of pigs slaughtered was so marked that much hope was entertained that it might be possible to completely control the disease. The very serious restriction to trade and the heavy expense has brought many protests from the producers. The recent report of the government veterinarian admits disappointment in not being able to stamp out the trouble.

In 1897 the government undertook an experiment in Page County, Iowa, to determine what might be accomplished by county police measures. The plan was to canvass a part of the county and determine the number of pigs raised the year before, the number that died and the number now on hand. Upon receipt of notice of an outbreak the veterinarian called and killed all the sick and paid the owner at market rates. Disinfection and general cleaning of the premises followed. It is believed by some that the saving more than paid the expenses.

Several of the States have laws upon hog cholera, but they usually define the manner in which the carcass shall be disposed of. Minnesota probably undertakes more than any other State and there the matter is in the hands of the State Board of Health. Canada demands a certificate of a clean bill of health from the State Veterinarian before they can be shipped in. The tendency is toward making transportation companies disinfect cars, yards, etc.

In our own state, the law requires burning or burial of the carcass;

it requires a statement of health to exhibit at the fairs and the disinfection of pens, etc., at fairs. It is an imperfect law but has been the means of saving many thousands of dollars.

DISEASE SIMILAR TO HOG CHOLERA.

Recently the Bureau of Animal Industry has described a disease that can not be distinguished from hog cholera but which is not due to the hog cholera germ.

Cause.—The germ causing the disease has not been described. The time between exposure and development of disease is from seven to twelve days. The hog looses appetite, is listless and by the second day appears sick. The flanks become hollow and the appearance gaunt and the gait becomes staggering. Dirrhoea may or may not develop. The symptoms gradually become worse and death occurs about the seventh day.

Appearance.—The skin is red or blotched and these are made up of numerous small spots. The lymphatic glands are enlarged and red. The stomach and small intestines appears normal or to have small red spots. The large intestines are covered with reddish spots and these run together near the rectum to make the appearance of a solid reddened area. The kidneys and lungs show the same reddened areas. The liver is mottled with gray. The spleen is enlarged.

Treatment.—None is recommended as too little is known concerning the diseaese.

ULCERATIVE STOMATITIS.

Infectious Sore Mouth in Pigs.

Causes.—This disease is common in pigs from a few days to several weeks of age and is infectious in character. No specific germ, however, has been found. Dusty, dirty or muddy quarters are among the predisposing causes. Under such conditions the sow's udder is exposed to dust and dirt and acts as a carrier of disease producing germs. The disease may be spread by diseased pigs infecting the teats of the mothers of healthy litters.

Symptoms.—The mucous membrane lining the lips and cheeks is

swollen and inflamed. This is frequently quite marked, the snout and lips becoming so badly swollen that the pig can hardly breathe. In the beginning the pig is careless of the teat and as the ulceration progresses, it becomes unable to suckle. The ulcers form quite readily on the lips, snout and tongue, appearing as light colored spots elevated above the healthy tissue. These soon break down and slough off, leaving deep cavernous excavations that may involve several of the teeth, or a large portion of the lips or snout. In extreme cases the end of the lower jaw or the whole snout may drop off. The ulcers on the face and body appear as brown scabs that soon open into deep pits or cracks. The pig acts very dull, is feverish and being unable to suckle, becomes greatly emaciated and soon starves to death. In advanced cases treatment does but little good. If recovery does occur, the pig is usually stunted, or deformed about the face or lips. The disease may end fatally in from three to ten days.

Treatment.—The preventive treatment is very important. The diseased pigs should be isolated from the healthy ones, the pens kept clean and disinfectants used freely. The diseased pigs should be dipped head foremost into a two per cent. watery solution of any of the coal tar disinfectants, or the mouth dipped into a solution of permanganate of potassium, (one ounce to the gallon of water). This must be repeated once a day for several days. It is also best to wash the udder of the mother with a similar solution. When the ulceration is well advanced, the dead tissue should be removed and lunar caustic rubbed on the parts. It is usually economy to destroy the badly diseased pigs.

TUBERCULOSIS OF HOGS.

The abattoir statistics published by the Bureau of Animal Industry show this to be a fairly common disease of swine. Tuberculosis has been increasing among hogs during recent years, but is not nearly as prevalent here as it is in European countries. There the disease is also more prevalent among cattle, and statistics show that the percentage of tubercular hogs increase as the affection becomes more common in cattle. The disease is more often seen in young than in old hogs, and is generally acute and generalized.

Causes.—The specific cause of tuberculosis is the bacillus tuberculosis, which was discovered by Koch in 1882, and can be found in the nodules and tubercules in the tissues of diseased hogs. These bacteria usually occur in the form of slender rods averaging from 2μ to 5μ, in length and have rounded ends. They may be seen singly, in pairs, and in small bundles, and do not form spores, but vacuoles. There is probably no disease producing germ which undergoes greater modifications under various conditions for environment than this one. Pigs generally contract the disease by eating infected food; skim milk, butter-milk and slops from the dairy. Young pigs may become diseased from sucking a tuberculous mother. The eating of tubercular carcasses may also cause it. Infection may take place through the inspired air, and when tubercular hogs are introduced into a herd, all the hogs in the pen may contract the disease.

Predisposing conditions are very important factors, and such conditions as act unfavorably on the constitutions of the pig, will, if the germs are present, favor the development of the disease. Close pens, filth, unnatural bringing up, early forcing, etc., all favor its development. Improved breeds of swine are said to be more predisposed to the disease than the common breeds. Infection has been known to occur by way of wounds, specially castration.

Symptoms.—These will vary according to the organ affected. In pigs the disease is often acute and generalized. Generally the symptoms are not well manifested, or the infection may be slight and the disease is not recognized by the owner unless a post mortem examination is made on some of the dead animals. In young pigs that have become infected by sucking a diseased mother, sympotms of intestinal tuberculosis may be manifested. The pig becomes runted, "pot-bellied" and emaciated. The visible mucous membranes are pale and the skin presents an unthrifty appearance, and may become covered with crusts. Digestive disorders occur, such as diarrhoea, bloating and vomiting. Manipulating the abdomen may cause the animal pain and sometimes a hard knotty mass, representing a bunch of tubercles, is felt. The pig is feverish at times.

If the lungs are involved there is a cough. This becomes more annoying as the disease progresses, sometimes the pig almost chokes. The breathing is quickened and labored. Frequently the superficial lymph glands in the region of the pharynx are affected.

In tuberculosis of the brain, nervous disturbances are noted, such as turning round and round, convulsions, spasms of muscles and paralysis. Only part of the body or certain groups of muscles are involved. The head may be held obliquely, the snout drawn to one side and the ears droop.

The course of generalized tuberculosis is short in young pigs, but may last for months in older ones. When localized, it is recognized only after the animal is slaughtered.

Lesions.—The changes in the tissues following the invasion of the baccillus tuberculosis are the formation of nodules or tubercules, gray or yellowish white in color, or translucent in character. In some cases those nodules are distinct and easily recognized, but in advanced cases they often come together and form a mass of tubercular tissue.

In the beginning the tubercle consists of a few cells surrounding the invading germs. These are soon enclosed in a zone of epitheloid and giant cells, which in turn become surrounded by a layer of lymphoid cells. The central portion of the tubercle soon dies and breaks down, and as the nodule enlarges, the necrotic portion gradually increases. When cut, the nodules or masses of tissue are usually made up largely of yellow caseous material. Sometimes it is indurated and almost as hard as cartilage. Calcareous degeneration of nodules is not often seen in hogs.

As the disease is nearly always contracted by the ingestion of infected food, the digestive apparatus and lymphatic glands are usually involved. Localized lesions in the lymphatic glands (pharyngeal and submaxillary) are very common. They become enlarged, knotty and hard. When cut open, they are made up mostly of old fibrous tissue with yellow caseous centers scattered through it. Ulcers and milliary modules may be seen in the intestines; yellow milliary granules may be scattered throughout the liver tissue, or tough nodules, yellowish white in color and varying in size from that of a pea to a hazel nut, may be seen; the peritoneum is sometimes the seat of fine granulations; and lesions the same as exist in the liver may be seen in other internal organs (spleen, lungs, etc.). When the disease is generalized, the muscles are sometimes affected.

Treatment.—We must take all precautions possible against infecting the herd by avoiding the feeding of infected food, and by keeping the hog houses and pens in the best hygenic condition possible. Hogs should not

be fed skim milk and slops from a dairy known to have tuberculosis, and it is a very bad practice to feed hogs the carcasses of other animals. When a hog has tuberculosis, it should be destroyed and the body disposed of in a suitable manner.

INFECTIOUS CATARRHAL PNEUMONIA OF THE PIG.

Causes.—There is a form of catarrhal pneumonia of pigs that is without doubt of infectious character. The infectious nature is established from the clinical history rather than from the finding of a specific organism. It affects pigs under four months of age principally, and is not attended with a very high death rate in those over two months of age.

When the disease is introduced into a piggery, it is almost certain to attack all susceptible animals. The period of incubation, that is the time elapsing from the period of exposure to that of the development of the illness is from ten to fifteen days. The young pigs become affected first, while a large percentage of those over four months will escape.

Symptoms.—The first and most prominent symptom is that of coughing and this persists throughout the entire course of the affection. There is also more or less difficulty in breathing. The cough at first is weak but soon becomes loud and is attended with considerable effort. It comes on in paroxysms and then there is a longer or shorter interval of quietude. The coughing spells are almost certain to occur when the pigs first stir about and when they take their meals. If the quarters are clean and the weather pleasant, the coughing is about the only symptom observable. The appetite remains good and the fever is not high. If the weather becomes cold, wet or stormy, the paroxysms of coughing come closer together, sometimes amounting to almost continuous coughing. There will be marked difficulty in breathing, loss of appetite and fever. The other symptoms of illness are rough coat, stiffness, and weakness. Under such conditions there will be a considerable loss of the weaker pigs in the litter and especially of those under eight weeks of age.

The disease may be confused with swine plague or hog cholera. It can be differentiated from the plague from the fact that the latter disease attacks older hogs and the death rate is highest in old hogs. It can be distinguished from cholera by the fact that there is little bowel disturbance and much lower death rate.

Post mortem.—A post mortem examination reveals clearly defined red patches spread over the lungs. They are most numerous along the edges, particularly along the lower edge of the anterior lobes. On section they show a uniform red color or dirty, rusty grey. They are more solid than normal tissues. There will be more or less frothy mucous in the diseased areas and the bronchi are injected with blood. The lung tissue is firm and dry. The lung pleura over the affected area is diseased but that opposite on the costal pleura is seldom involved. The heart and pericardium remain normal unless the lung is affected in the immediate vicinity. The bronchial glands show enlargement. The abdominal viscera remain normal.

Treatment.—As far as possible, the treatment should be preventive. Pigs that are coughing should not be turned into lots with pigs that appear healthy. Should the disease break out in a litter, the whole litter should be removed from the piggery, the bedding burned and the pen white-washed. The pigs should not be allowed on the range used by other pigs.

The treatment of the disease itself consist in securing dry, clean quarters, as little exposure as possible, rich but not bulky food, and trust that age will help give resistance. The administration of creolin or coal tar creosote preparations at the rate of a teaspoonful to the hundred pounds of weight has a good effect. It is best given mixed with the milk.

ACTINOMYCOSIS.

Causes.—Actinomycosis is an infectious disease commonly seen in cattle, but may occur in hogs. The specific cause is a fungus, *Cladothrix actinomyces* or ray fungus. Its natural habitat is on plants (barley, wheat, etc.), and it has been found on the awns or beards of these grains imbedded in the tongue of hogs. The fungus gains entrance to the body through a wound in the mucous membrane of the mouth or in some other part and may follow castration. Inhalation of the fungus will cause the disease.

Symptoms and Lesions.—These occur as a result of the fungus multiplying in the tissues and causing them to break down. Tumors form on the jaw or in any part of the body as a result of the infection. Frequent-

ly the lungs are affected. When the disease is generalized, the pig presents an unthrifty appearance. As in tuberculosis, the disease may not be recognized until the pig is slaughtered.

The fungus appears in the affected tissues or in the pus from an abscess, as very small yellow granules that can be seen with the naked eye. These granules when placed under the microscope are found to be made up of rosettes, each one composed of a number of club shaped bodies radiating from a central mass which is composed of the mycelial part of the fungus, a fine thread like structure. The clubs vary in size, but are usually from 1_{μ} to 10_{μ} long.

Treatment.—The most practical method of handling actinomycosis in pigs is to send them to the abattoir. In most cases the lesions are localized and the part is tanked. If generalized,the animal should be condemned. If we desire to treat the pig, twenty grains of iodide of potassium can be given in the feed daily for at least two weeks, or until symptoms of iodism are produced. The drug must be then discontinued, and if the tumor does not become smaller in a few weeks, the treatment should be repeated.

ANTHRAX.

Some literature on diseases of the hog regard hog cholera and swine plague as forms of anthrax. Formerly this error was not well understood by swine breeders, and undue prominence was given to a disease that is rarely seen in hogs outside of permanently infected sections of the country. We have never seen a case in this State.

Causes.—Anthrax is caused by an organism, *Bacillus anthracis*, and is found in the diseased tissue from animals affected with the disease. If the tissues of an animal that has died of this affection are exposed to the air, the germ will form spores which are very resisting to destructive agents. When once these spores are introduced into a locality, they tend to remain there for years, and whenever the conditions are favorable, will cause an outbreak of anthrax. These spores are frequently carried on the hides, wool, hoofs, horns, etc., removed from cattle having anthrax, and outbreaks may occur as a result of the refuse from tanneries infecting

pastures on which sheep and cattle graze. Hogs are not very susceptible to anthrax, and the common mode of infection is by feeding on the carcass of some animal that has died from the disease. Cases have been reported, however, where the disease was due to inoculation with the germ.

Symptoms.—The pharyngeal and intestinal forms of anthrax are the most common in the pig. The animal is feverish, the breathing labored and there is difficulty in swallowing food. The pig is very weak and disposed to lie down most of the time. A swelling may appear in the intermaxillary space and spread along the course of the treachea and the neck is usually stiff and saliva dribbles from the mouth. The skin is sometimes stained with blood, the mucous membranes cyanosed or dusky brown. Ulcers may form on the mucous membrane lining the throat, tongue and palate. Carbuncles sometimes form on the skin, especially on the back. Death occurs from suffocation.

Lesions.—The blood is tar-like in appearance, and hemorrhages varying in amount from small petechial spots to a permeation of the organ or tissue are seen. Submucous, subserous, and subcutaneous gelatinous and serous infiltrations occur. At the seat of the inoculation the tissue may be necrotic. The spleen is enlarged and there is a parenchymatous inflammation of the liver and kidneys. In the very acute cases these changes are slight. The longer the course of the disease, the greater are the changes in the tissues. The bacillus anthracis is present in the diseased tissue and in order to confirm a diagnosis, we should prove its presence.

Treatment.—Hogs should not be allowed to feed on the carcass of an animal that has died of anthrax. Preventive precautions are all that is necessary and no serious losses will occur if the dead animals are disposed of in the proper manner.

RABIES. HYDROPHOBIA.

Madness.

Rabies is one of the oldest known infectious diseases. Hogs do not suffer as extensively from it as do dogs, cattle and horses, but wherever an extensive outbreak of rabies occurs, hogs are usually reported as dying from the disease.

Causes.—The specific cause of rabies is not known, but its being due to

a specific germ cannot be disputed. Rabies is a disease produced by inoculation, and in most cases is due to the bite of a rabid dog. The saliva of all animals infected with the disease contains the virus of rabies, but carnivorus animals are the only ones that have a very good opportunity to bite other animals when affected. However, the saliva from any rabid animal, if rubbed into a wound or break in the skin may produce rabies. Hogs sometimes show a disposition to bite and may infect other animals. The average period of incubation is from two to three weeks.

Symptoms.—Rabies in hogs is characterized by very much the same train of symptoms as occurs in other animals. The hog is very restless and excitable, and if lying down or hidden in the litter may jump up suddenly, squeal and run about as if pursued. They will back up as closely as possible in the corner of the pen. The squealing has a peculiar crying sound. They are very nervous and easily startled and will break for a person or other stock. The eyes are at times fixed or may roll about, and there is an abundant secretion of saliva. Frequently they will gnaw the boards of the pen and make desperate efforts to get out. They will bite other animals and swallow indigestible substances. Swallowing is difficult on account of the early paralysis of the muscles of degluition.

The duration of the disease is short. Paralysis occurs early and the hog lies or hides in the litter most of the time and pays no attention to its surroundings. It becomes weak or emaciated and dies in a few days.

Lesions.—The changes in the tissues are neither constant nor specific. The most constant lesions are microscopic in character and are found in the brain. A congested condition of the mucous membrane lining the pharynx, larynx and stomach, enlargement of the spleen and hyperemia (congested condition) of the brain are sometimes seen. Frequently the stomach contains foreign matter, such as stones, straw, pieces of wood, etc.

Treatment.—The treatment of hogs in any way is not practical. As soon as a hog develops rabies, it should be destroyed or isolated in order to prevent its spreading the disease.

TETANUS.

Lockjaw

Causes.—Tetanus is caused by a specific germ, *Bacillus tetani.* This organism exists in most soils but is more common in some localities than

in others. In warm climates it is more abundant than in cold, and dirt rich in organic matter seems to be the favorite place for it.

It enters the body by way of a wound, sometimes so slight as to escape observation. It may follow as a result of castration, and any deep or punctured wound that is not open to the air is a suitable place for its development. Tetanus germs differ from some of the other forms in that they do not enter the circulation and become distributed to different parts of the body, but remain at the point of infection. There they manufacture poisons (toxines and ptomains) that are taken up by the circulation and have an action on the nervous system similar to strychnine.

Symptoms.—The acute form of the disease is usually seen in hogs. The spasms begin with the muscles of the jaws and face, and spread rapidly to other parts of the body, involving especially the back and limbs. Shortly, the hog becomes unable to stand, falls on its side and can not get up. It remains in this position with the limbs extended and rigid. The respirations are labored; frothing at the mouth is noticed and convulsions may occur. The protrusion of the third eyelid is characteristic of this disease. It is very fatal in pigs.

Treatment.—This is limited to preventive treatment, and consists in taking all the necessary precautions against infection at the time of castration and spaying. Medicinal treatment is of little use. The hog should be placed in a pen by itself and kept as quiet as possible. If it will eat, a sloppy diet should be offered. The bowels must be kept open by injections and cathartics.

SIMPLE PYAEMIA AND SEPTICAEMIA.

Blood Poisoning.

There are two forms of blood poisoning. In the first the germs are picked up by the blood stream while passing a wound and distributed throughout the body. The result is to cause abscesses or boils in various places, on the surface, and in the organs, as the lungs, liver, kidneys. etc. The distribution may be local instead of general and we have the infection following up a leg or spread out in the body. Its characteristic is the extension of pus. This is known as pyaemia.

In the second form there are pus germs present at the wound or point of infection but instead of these being carried away by the blood

they remain, and as they grow, produce a poison and this is absorbed and carried about. This may produce profound general shock to the system or inflammation of certain organs. Both conditions may be present at the same time.

Causes.—These are the pus producing microbes, especially staphylococcus pyogenes aureus or albus and streptococcus pyogenes, that enter the tissues through bruises or abrasions permitting the germs to become lodged beneath the skin, or through extensive wounds. Sometimes they remain at the point of infection, but may be transferred from here by the blood stream to distant points, forming suppurating centers or infect the tissues generally and become widely distributed. This condition is not rare as a result of putrifactive changes in the uterus following an inflammation of the organ, or as a result of retention of the foetus.

Symptoms.—Unless the symptoms follow an extensive infection resulting from a difficult birth, an operation or a large wound, the owner does not connect them with a disease of this nature. At the point of infection, an abscess may form or the part become greatly swollen and oedematous. The body temperature is elevated and in serious cases the appetite becomes impaired. Muscular tremors may be noticed, and the hog becomes dull and stupid. It is generally seen hiding in the weeds or litter or in some cool, quiet place. Sometimes the animal has a diarrhoea. In serious cases, it becomes greatly emaciated and death takes place in a few days. Recovery frequently occurs, and in time the hog begins to thrive.

Treatment.—The treatment is mostly preventive, and consists in proper care being given most wounds, especially if extensive, and in using antiseptic precautions in all operations on the pig. Abscesses should be opened promptly and at the lowest point, so that all the pus can drain out. The after treatment consists in washing the cavity with an antiseptic wash for a few days, and the opening should not be permitted to close until the cavity has entirely filled in. In large wounds we must try to bring about the formation of a healthy granulating surface as soon as possible. If necrotic or dead tissue forms in the wound, it must be removed and a healthy surface promoted by the use of antiseptic dressings. In cases of local septicaemia, this is all the treatment necessary. When the disease is generalized, the treatment is usually hopless. Alcohol, salicylate of soda, and quine are the drugs usually given in these cases.

Plenty of clean water should be allowed. The animal should be coaxed to eat easily digested and highly nutritious food in order to prevent its becoming weak.

INFECTIOUS ARTHRITIS.

Causes.—This disease occurs in pigs a few days old and is caused by septic germs that enter the system by way of the navel or umbilicus. Filth and dirty pens are among the predisposing causes. If the disease has once occurred in a pen, it is very apt to recur from year to year. Sometimes it assumes the proportion of a local epidemic and causes very heavy losses in a neighborhood.

Symptoms.—The pig becomes very weak, refuses to suckle, is feverish and usually has a diarrhea. The affected joints are swollen and painful. Abscesses form in different parts of the body, sometimes about the umbilicus and may contain considerable pus. Occasionally the abscesses about the joints break or one of the feet drops off. In case the pus is along the umbilicus, it may discharge outside and recovery takes place. If it discharges into the abdominal cavity, death is sure to occur.

Treatment.—This is wholly preventive. If the disease exists in a litter, the pen should be thoroughly disinfected and the bedding burned. Sows should not be permitted to farrow close to an affected litter, or in a pen where an affected litter has been kept, unless it has been well cleaned and disinfected. Washing the umbilical cord with a ten per cent solution of creolin or carbolic acid should be practiced when the disease is present in a herd. This will cause the cord to become hard and dry, and will prevent the entrance of the germs as well as disinfect the cord.

PARASITIC DISEASES.

THE HOG LOUSE.

But one specie of lice attack hogs. It is a common parasite, however, and often appears in formidable numbers on unthrifty pigs. The hair affords the lice but little protection, and vigorous, healthy hogs are able to dislodge the pests by rubbing against the sides of the pen and against one another. When hogs reach the abattoir during the warm weather,

the adult louse is seldom found on them, but plenty of "nits" are usually seen. The lice become dislodged during the shipment and in the pens by the frequent soakings with water that the hogs receive, and by their rubbing against each other.

It is only when a hog is unthrifty or sick that lice are a serious menace to the animal. When in this condition, the hog seems to be unable to dislodge them and they multiply very rapidly. The bite of the hog louse is very irritating and it lives by sucking the blood of its host. The

The hog louse and eggs.

irritation from the bites makes it almost impossible for the hog to rest, and if sick, they help to increase the anemic (bloodless) condition. Lice are a serious handicap to growing pigs, interfering with their appetite and general nutrition. They are said to cause urticaria (nettle rash or heat sores).

Because of the thinness of the hair and the size of the parasite, it is quite easily seen. The favorite seats are back of the ears ,along the neck, under the breast, back of the arms and on the inside of the thighs, in fact

any place where the skin is moderately thin, and it is not easy to dislodge them.

The hog louse, (*Hæmatopinus uris*, Nitzsch) is one of the largest species of the family. When full grown it measures a fourth of an inch or more in length. Its general color is gray with the margins of the head and thorax and most of the abdomen dark. The head is quite long, the sides nearly parallel, with strong eminences just back of the antennae which are set on the side of the head midway from rostrum to occiput; the legs are lighter with dark bands at the joints; the spiracles are enclosed by a black, chitinous eminence, and there is a broad, black band broken near the middle on the last segment.

The male has the abdomen marked beneath with a large black area extending forward from the terminal segment. On the feet is an organ that helps the louse to cling to the hair.

The eggs are six-hundredth of an inch in length, by three-hundredths of an inch in width, are slightly yellow or dusky whitish in color, and taper somewhat toward the point of attachment. They are usually attached near the base of the hairs.

Treatment.—It is more difficult to kill the lice scattered around the hog houses and yards than it is the ones on the hogs. For this reason it is difficult to get rid of the lice in a drove of hogs, as they again become infected in the sleeping quarters or about the pen. The hair affords but little protection and makes the application of remedies for their destruction quite easy. A number of different remedies and methods of applying them can be used. Kerosene, any of the coal tar products and crude petroleum are common remedies. The hog can be sprayed or dipped with these preparations.

An ingenious method of applying the oil is by means of the rubbing post. A good solid oak post a foot or a foot and a half in height is placed in position in the hog lot. One hole is bored in the top to a depth of about eight inches, and two at right angles from the sides, at the bottom of the vertical hole. Soft pine pins are driven in the side holes. The upright hole is filled with kerosene and stoppered. Next a burlap strip eight or ten inches wide is wrapped around the post over the side holes. This after a time becomes soaked with kerosene and the pig will rub against it at the place where it will do the most good. It is not, however,

a very thorough way of using the remedy. A better way is to use a spray pump having an attachment for mixing the oil and water. Five parts of water and one part oil should be used. Three or four sprayings are required to kill all of the lice, and should be done at intervals of a week

Dipping vat for hogs.

and in the evening. If done in the evening, by the next morning the oil is evaporated and there is no danger of the sun blistering the skin, as would be the case if applied during the early part of the day.

The coal tar preparations are to be preferred as remedies for lice. These are zenoleum, chloronaptholeum, milk oil, daytholeum and a number of others. The hog can be sprayed or dipped with any of these pre-

parations. Dipping is to be preferred and is a very effective method of getting rid of lice. Pigs a few weeks old can be caught and immersed in a barrel. If a large number are to be treated, it is best to have a dipping tank. The tank should be sunk in the ground and contain enough of the solution to cover the hog when it jumps into it.

Crude oil is the cheapest material to use as a dip. The tank is filled with water to the desired depth, and one inch of the oil poured on the top of it. The hogs are then driven through, and a thin layer of oil is deposited on every part of the animal.

MANGE. SCABIES.

This affection of the pig is frequently alluded to in journals devoted to the swine industry, and is described in nearly all of the old works on diseases of swine. It is a rare affection and of little economic importance. Because of the disease being so frequently mentioned, we include it with the other parasitic diseases, although we have never seen a case in this state.

Hogs have two forms of mange; the sarcoptic form, due to the *Sarcoptes scabies* var. *suis*, and the demodetic form, due to the *Demodex folliculorum* var. *suis*.

The demodex of the pig, (*Demodex folliculorum* var *suis*, Simon) is a worm like parasite, shaped something like a laurel leaf and about one one-hundredth of an inch in length and one-fifth as broad. It comprises three parts; head, thorax, and abdomen, the first two being joined in a single organ. The mouth parts are horse shoe shaped. Their length and the cephlo-thorax is about equal to the length of the abdomen. The mouth parts comprise, first a pair of mandibles; second a pair of jaws; third a narrow tongue. On the sides of the thorax are four pairs of short, mobile legs formed of three parts, the last part being fitted with two claws. The abdomen is long, conical and striated transversely. It shows at the anterior part of its ventral face a longitudinal slit, the anus, which is much larger in the female than in the male, and may serve for copulation and ovulation. The abdomen of the male is less developed than that of the female, and possesses a genital armature situated immediately in front of the anus.

The young parasites are small and narrow and have but three pairs of legs. The eggs average twenty five-hundredths of an inch long and are ovoid in shape. The larva undergo three metamorphosis before reaching the adult state. It no doubt passes through the different stages of development in the follicles of the skin, but may migrate over the surface of the skin when they reach the adult stage and before laying eggs.

Symptoms.—The finer parts of the skin are affected; the snout, neck, chest, abdomen, flank and inner part of the thighs. The inflammation begins in the region of the hair follicles and sebaceous glands. Pimples and pustules appear, varying in size from that of a grain of sand to that of a hazel nut. As the disease progresses large purulent islands varying in size and containing many acari are formed. Ulceration may follow. In the older diseased areas and when the disease lasts for a long time, the skin becomes sclerotic (hard) and many times its normal thickness. Inside of the pimples the mites can be found in all stages of development. In the small abscesses there may be from fifty to one hundred, in the larger ones a thousand. Follicular mange is said to be more contagious in the hog than it is in other animals, and is considered a serious disease.

The scab mite (*Sarcoptes scabeii* var. *suis.* Lahr,) is one of the largest of the specie and when found, can be seen with the naked eye. They work deep in the skin, and it is difficult to find them. The female is about one-fiftieth of an inch long and almost as broad. The male is not as large. The mite has eight very short, thick, conical shaped legs, the two posterior ones being quite, or almost concealed beneath the abdominal surface. On the dorsal surface are a number of parallel ridges interrupted by conical projections. Toward the posterior part of the body are a few hairs.

Symptoms.—It begins with a violent itching about the head, especially at the base of the ears, about the eyes, and gradually extends to the neck, withers, inner surfaces of the thighs and the whole body. The invaded areas of the skin are first covered with little red pimples. Abrasions from the hog rubbing itself soon occur. The secretions and scales from the skin gradually accumulate, the bristles drop out or become matted and the skin is greatly thickened and wrinkled. In old cases the scales on the skin give it a dirty white color.

The mites live in galleries in the deeper layers of the skin and they multiply rapidly. Hog mange is not communicable to other animals.

Treatment.—Hog mange is difficult to treat. It does not seem to spread rapidly among hogs, and can be controlled by isolating or destroying the affected animals. The pig houses and pens should be disinfected, or the pigs moved to fresh quarters after being treated. The skin must be rubbed with a strong alkaline soap before applying the remedy in order to remove as many of the scabs as possible. A tobacco dip can be used, but in severe cases a mixture of eight parts of turpentine and one part flowers of sulphur is a better remedy. It is best to apply the remedy with a brush and rub the skin quite hard. Sulphur or nitrate of lead ointment may be applied when the infection is slight.

INTERNAL PARASITES.

THE COMMON ROUND WORK.

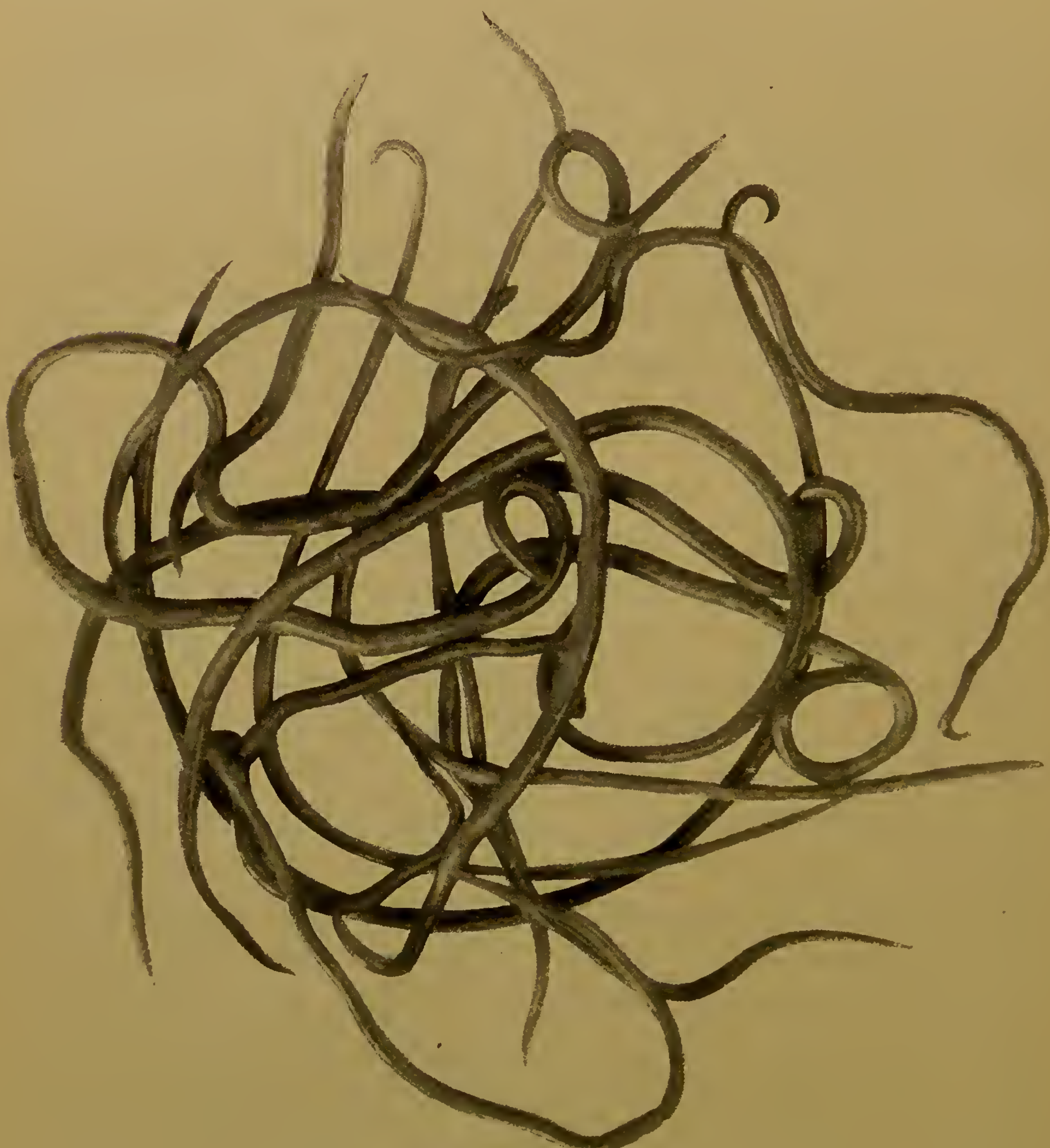
Ascaris Suilla.

The natural habitat of the common round worm is the small intestine. It is sometimes found in the large intestines and the stomach. Its presence in the stomach occurs only when the hog is dead, and is reached by a reverse peristalsis of the intestines or the movement of the worms themselves. When quite active and present in large numbers, they may work forward into the oesophagus. It is not uncommon to find them extending into the common bile duct, some even enter the gall bladder, while others imbed themselves in the ducts coming from the various lobes of the liver.

In young unthrifty pigs round worms are common parasites, and it is not unusual to find from ten to twenty of them in a single individual. They may be present in such numbers as to almost fill the lumen of the intestines for several feet of its length. There are few pigs over the country that do not harbor this parasite to a greater or less extent. Men who treat hogs for cholera and swine plague, are quite familiar with this worm, and report it as being quite common.

Description.—The *Ascaris suilla*, Dujardin, is a large round worm, tapering at both ends, and white, or yellowish white in color. The body is firm and elastic, the digestive tract quite complete. The average length of the female is ten inches, that of the male six and a half inches. The head is small and armed with three lips, the upper one having a papillae at each

of its inferior angles, the other two at the middle of their base. The female organs consist of a pair of convoluted tubes, each dilating into a uterus and uniting to form a single tube, the vagina. The opening from the vagina, the vulva, is situated toward the anterior third of the body in



Large round worms.

the middle of an anular constriction. The male organs are simple, consisting of a single convoluted tube dilated below to form a seminal vesicle, and terminating in an ejaculatory duct which opens into the cloaca. The posterior extremity is furnished with a large number of papillae, some

of which are back of the anus. The ova are about one four-hundredths of an inch in length.

Source of Infection.—The eggs of the ascaride are passed out with the excreta and drop to the ground. Moisture and warmth are necessary for their hatching, but they seem to be able to live under unfavorable conditions and will resist drying for some time. When the conditions are favorable, the eggs hatch and the pig becomes infected by taking the immautre form into the digestive tract along with the food, or the embryo, when well formed in the egg, reaches the digestive tract with the food, the shell is dissolved by the gastric juice and the embryo liberated. Earth eating pigs are almost sure to become infected. Feeding hogs on dirty feeding floors or on the ground, and drinking from ponds and dirty watering troughs are common sources of infection. The best of hygenic conditions may not prevent infection, but will greatly lessen it.

Symptoms.—Unless a number of ascarides are present in the intestines, no marked symptoms of disease occur. Whenever the pigs are kept under conditions unfavorable for growth, they usually become infested with a large number of intestinal parasites, and the irritation to the intestines will help in causing the animal to become stunted. They also obstruct the passage of the food along the intestines, and the maintenance of the colony of worms taxes the animal to some extent. The symptoms shown do not differ greatly from those seen in chronic indigestion. The presence of worms in the faeces help very much in diagnosing the trouble. Pigs weighing from twenty five to one hundred pounds are the most frequent sufferers. In thrifty old hogs, they are never present in large enough numbers to cause any harm. Young hogs are sometimes very restless, and may manifest other nervous symptoms.

Treatment.—The preventive treatment is very important, and consists in bettering the sanitary conditions under which the pigs are kept. Wallow holes should not be allowed to form in the yards, the water supply should come from a deep well, and clean feeding floors and watering troughs provided as far as possible. To enable the pigs to resist invasion, they should be kept in good condition.

To destroy the worms or drive them out of the intestines, a number of different drugs can be used. The simplest treatment for intestinal worms is turpentine in milk. The dose given is one teaspoonful of tur-

pentine for every eighty or one hundred pounds of live weight, and is more effective if repeated three days in succession. A mixture of powdered areca nut and worm seed in teaspoonful doses is also recommended.

Large round worms as found on opening the intestine.

Santonin five grains and calomel three grains for every eighty pounds of live weight is a very effective remedy for round worms. All powdered drugs are best given in ground feed and should be well mixed with it.

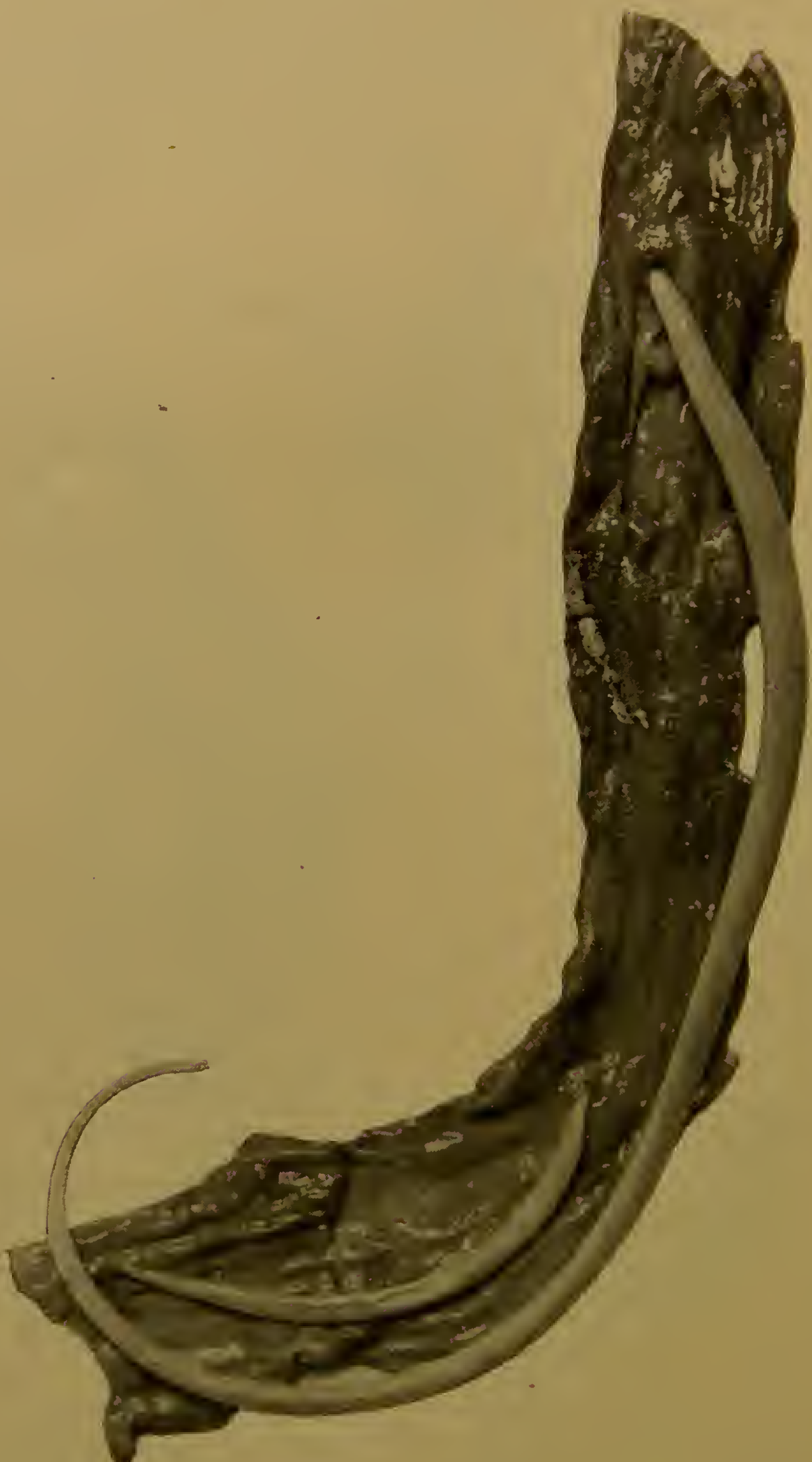
or each pig will not get the proper dose. In dosing a large number, they should be divided into small bunches and each bunch dosed separate. The best results are gotten when the pigs are starved for about twelve hours before giving the remedy, and when a physic is given along with it or immediately after. Castor oil or calomel are the physics usually given, especially the latter, as it is very effective and can be readily given along with powdered drugs. Turpentine need not be followed by a purgative.

THE THORN HEADED WORM.

Among the parasites of the small intestines occurs one specie of the genus Echinorhynchus. It is usually found with its proboscis imbedded in the wall of the small intestine, well toward the anterior part. It is seldom found in the large intestines. The round and thorn headed worms are frequently present in the same animal, but the two genera are quite distinct, and the most careless observer is able to distinguish between them. The echinorhychus is not as common as the ascaride, and is not found in as large numbers. It is uncommon to find more than five or six thorn headed worms in the one animal. The loss occasioned by this parasite some years is quite large. A single slaughter house in this state estimated their losses at $7,000 due to poor sausage casings. This must be only a trifle compared with the loss to farmers from lack of thrift.

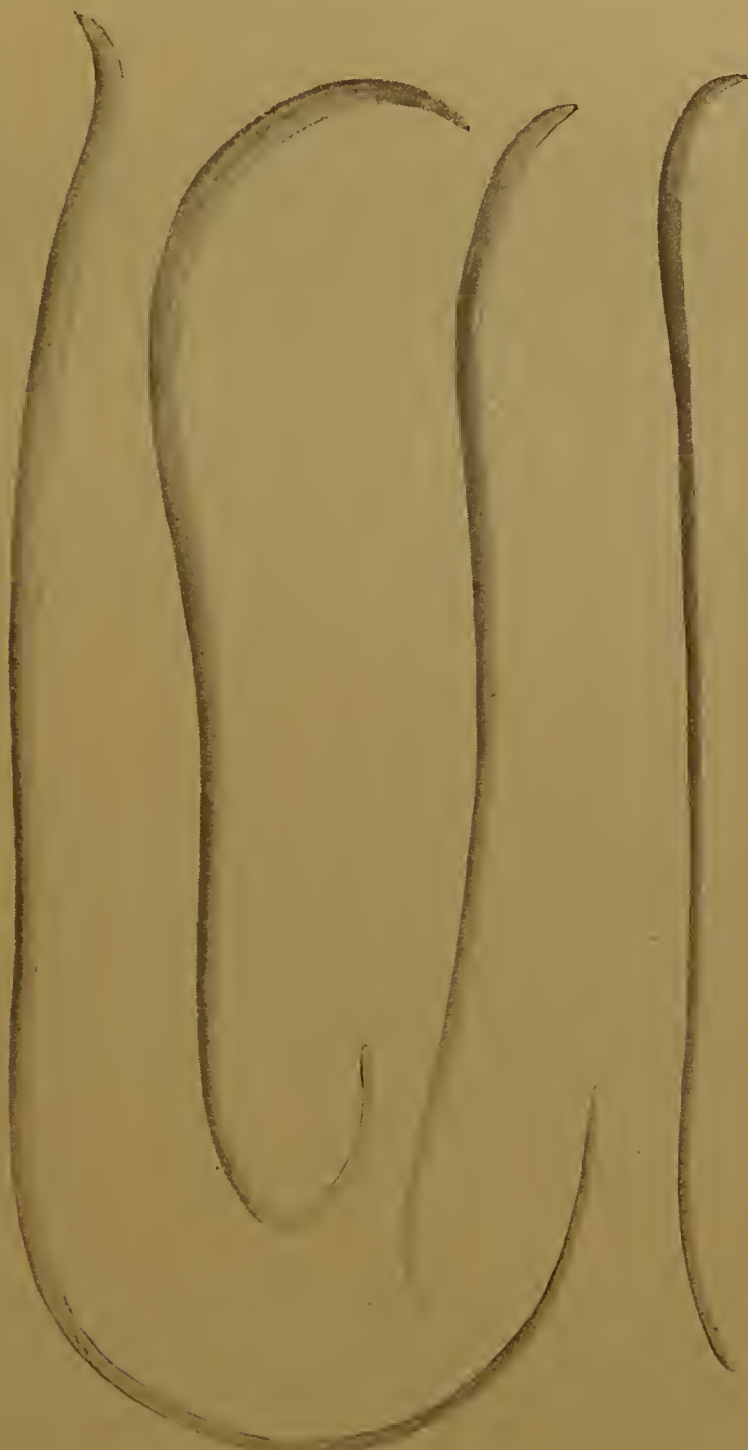
Description.—The *Echinorhynchus gigas*, Goeze, is larger than the ascaride. The female when full grown is the largest worm infesting hogs. The average length of the male is three inches, that of the female ten inches. The body is milky white in color, irregularly wrinkled transversley and tapering to a blunt point at its posterior extremity. At the anterior extremity is a retractile proboscis or rostellum, almost globular in shape and armed with six or eight rows of chitinous hooks which curve backwards. This organ can be retracted into a muscular sheath to which are attached strong retractor muscles situated toward the anterior part of the body cavity. At the base of the rostellum, and hanging down into the body cavity are two muscular sacks, that are considered by some representatives of a digestive tract. No digestive tract is present. The genital opening in both sexes is at the posterior extremity of the body

The eggs average about one two-hundred and fiftieth of an inch in length, and are smooth and cylindrical in shape.



Thorn-headed worm attached to the intestine.

Source of Infection.—The eggs pass out with the faeces, become mixed with the manure and scattered around the pens and pastures. White grubs which are very plentiful in dung heaps become infested with the immature



Thorn-headed worms.

form of the worm, and act as intermediate hosts. Hogs become infested by eating the grubs which they will search very diligently for in loose

rich soil. The per cent. of infection will vary according to the locality and the season of the year. Those pasturing upon sod, especially clover sod, show greatest infection.

Symptoms.—When a number of thorn headed worms are present in the intestines, they greatly irritate the lining membrane and cause serious symptoms of disease, especially in young pigs. The symptoms as described by observers are loss of appetite, constipation, diarrhea, restlessness, general emaciation, weakness of the loins, and in very young pigs, convulsions and spasms. When the infection is light, no noticeable symptoms occur.

At the point where the worm attaches itself, the intestinal wall is inflamed. The inflamed tissue is about a quarter of an inch in diameter and depressed in the center where the rostellum is imbedded. Sometimes the head of the worm is buried more deeply than the mucous coat, and the muscular and serous coats become inflamed. Perforations of the intestines have been reported, but such a lesion should be questioned. When the intestines are badly infested by parasites, they are easily torn when handled because of the inflammatory changes in their walls, and the tear is sometimes mistaken for a perforation.

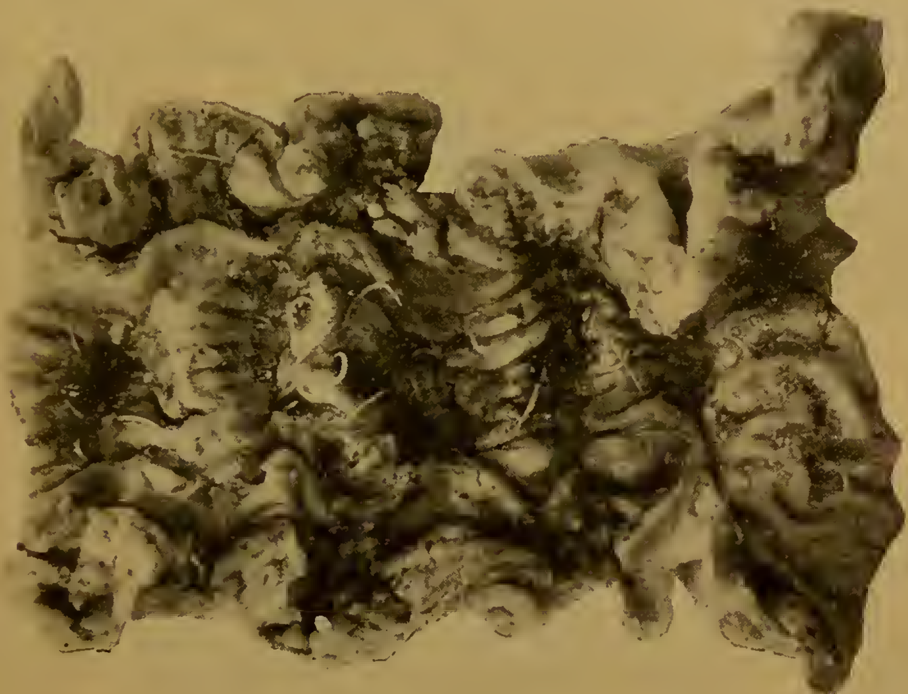
Treatment.—As a preventive measure, we should not allow hogs to root around old straw stacks and manure heaps. Sometimes white grubs are very plentiful in old hog lots. Plowing the lots occasionally will help to free them from grubs. The turpentine treatment as recommended for the common round worm is a very effective remedy, and should be given three days in succession. Better results are gotten if the hogs are dieted over night, and the turpentine administered in the morning.

THE PIN WORM.

The pin worm, *Oesophagostoma dentatum*, Rud, is quite small. It inhabits the caecum and colon of hogs, and may be found in large numbers in this part of the intestine. Unless looked for carefully, it escapes notice.

Description.—The body is white or brownish in color, straight and pointed at both ends. The male is half an inch in length; the female a little longer. The mouth is circular and surrounded by a ridge on which are several papillae. The caudal pouch of the male is bell shaped and

rounded, with a faintly marked middle lobe. That of the female is pointed. The vulva is situated in front of the anus and surrounded by a raised ring.



Caecum worms.

Pin worms cause but little if any digestive disturbance. Irritation to the walls of the caecum or colon does not interfere as much with digestion, as would an irritation to the stomach or small intestine. They are seldom present in large enough numbers in the intestine to cause any noticeable irritation, but no doubt in conjunction with other parasites, they help to aggravate the symptoms of parasitism. The pig becomes infested through the food supply.

THE WHIP WORM.

Description.—The whip worm, *Trichocephalus crenatus*, Rud, is commonly found in the large intestines, generally the caecum. It is about one and a half inches in length. The anterior two-thirds of the body is capillary and very thin, the posterior one-third suddenly expanded, thick and cylindrical in shape. The caudal extremity of the male is coiled, and a number of short spines are seen behind and around the sheath of the spicule, the point of which is rounded.

Method of Infection.—Pig becomes infected by taking the eggs into the digestive tract along with the food. The eggs usually contain well formed embryos which are said to develop into the adult form in about four weeks.

Symptoms.—No serious trouble is attributed to either whip or pin worms. When present in large numbers, they no doubt cause considerable irritation and may aggravate the symptoms in other parasitic affections.

Treatment.—The same treatment as recommended for other forms is indicated here. In addition rectal injections of soapy water can be administered.

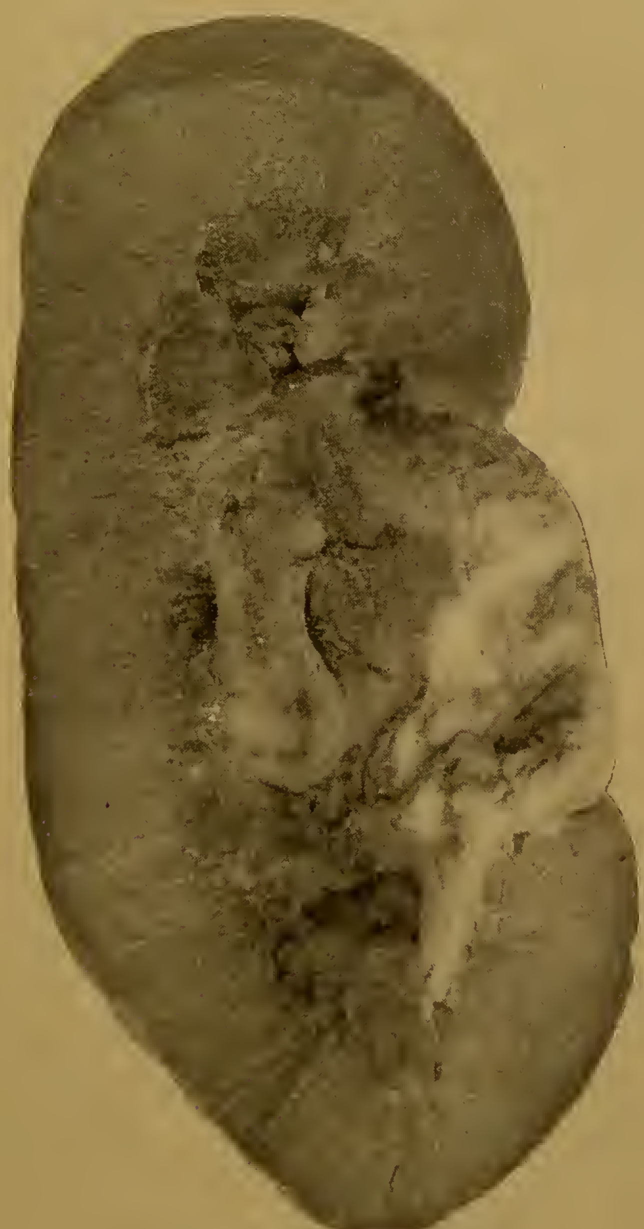
THE KIDNEY WORM.

When a hog is paralyzed in its hind quarters swine breeders usually call the disease "kidney worm." This statement may also be used when the pig is not doing as well as it should. A few years ago the kidney worm was claimed by some to cause hog cholera and swine plague. The origin of these statements is not reliable, and the presence of the worm under such conditions is only a coincidence.

The kidney worm occurs in the fat around the kidney, in the kidneys and sometimes in the liver. It is usually found in cysts or canals and several may be seen in one cyst. They more often occur in pairs. As a result of the irritation, there is more connective tissue in the region of the cysts than in the rest of the fat, and it may contain pus. It is not uncommon to find kidney worms in the pelvis of the kidney, and frequently its walls and the ureter are inflamed and thickened. Sometimes the kidneys are inflammed and contain abscesses. This latter condition in the absence of the kidney worm is not uncommon.

Description.—The kidney worm, *Stephanurus dentatus*, Dies, is mottled but when seen against the fat appears dark colored. The body is cylindrical, plump, and slightly tapering at both ends. The male is from an inch to an inch and a half in length and about one twenty-fourth of an inch thick. The caudal extremity forms a blunt end, in which is situated the anal and genital openings. Surrounding the body openings is a six lobed bursa. There are two long slender spicules having muscles attached to their upper ends, and when extruded, can be drawn within the

body. The female is some larger than the male and will average about an inch and a half in length and one twelfth of an inch thick. The curved tail has a conical shaped tip and is winged lateraly. The anal opening is very close to the extremity of the tail, and ventral; the vulva



Kidney worms in the kidney.

is situated about one twenty-fifth of an inch in front of the anal opening. The reproductive organs consist of two ovaries, two oviducts, two uteri and a bicornate vagina. The eggs are oval in shape and about one two hundred and fiftieth of an inch in the longer diameter.

The mouth is terminal, circular in shape and surrounded by papillae.

The alimentary tube can be divided into buccal cavity, oesophagus, stomach, intestine, and rectum.

Method of Infection.—The way in which hogs can become infected has never been demonstrated. In all probabilities the eggs pass out in the urine, and the embryo after developing for a time in some moist place or in water, is taken into the body with the food the same as in other parasitic forms. It is believed that no intermediate host is required and the infection occurs direct.

Symptoms.—Hogs affected by the kidney worm rarely show symptoms of disease. In some cases diseased changes are noted in the kidneys and in the fat around them; sometimes the liver shows a few lesions. In these cases the symptoms are the same as manifested in diseases of these organs. This parasite seems to be of little economic importance.

Treatment.—The preventive treatment indicated is the same as for the intestinal forms. It is useless to try and treat them as they are beyond the reach of any medicine, unless by such drugs as are eliminated by way of the kidneys.

THE LUNG WORM

Whooping Cough.

The lung worm, *Strongylus paradoxus*, Mehlis, is a common parasite of pigs under six months of age. It is found in the bronchial tubes. When the infection is slight the worms are found mostly toward the apex and margin of the lungs. In these cases the lesions are not marked, and it is necessary to examine the lung very carefully in order to detect them. In examining lung tissue for this parasite, it is best to cut off the apex, and by squeezing it between the fingers, force the lung worm out of the broncheole onto the cut surface of the lungs, where they can be readily seen. It is the only lung worm affecting hogs, and may occur in sheep.

Description.—The male is a little over three quarters of an inch in length. The bursa is provided with numerous folds; the caudal extremity at the base of the bursa is curved toward the ventral aspect and two long tubular spicules project outside about one-tenth of an inch. The female

is from an inch to an inch and a half long. The vulva is surrounded by a vesicle or bladder like body, visible to the naked eye. Surrounding the mouth are six lobes, the two lateral ones being the largest . The color is whitish or brown.

Lesions.—These are usually slight, and depend on the number of lung worms present or the duration of the infection. The worms are found in the bronchial tubes mixed with the mucous, and when badly infected, the mucous membrane lining the smaller tubes becomes inflamed. As well as irritating the air tubes, it acts as a mechanical obstruction by plugging up the smaller bronchi, and causing a lobular pneumonia. The involved air cells usually return to the normal, but may go through other diseased changes. In some cases the effect is to enlarge the bronchi or to cause saculation.

Method of Infection.—The life history of the lung worm is not fully known. In most domestic animals infection with lung worms depends largely on the humidity of the soil, and is more prevalent on swampy pastures containing ponds and stagnant water than it is on high ground. This disease is more prevalent during wet seasons. Lung worms are often present in pigs when kept under the best possible conditions.

The eggs are laid in the bronchial tubes. Before they hatch it seems necessary for them to be expelled by coughing, and undergo a part of their development outside of the body. Just what these changes are is not known. In all probability the pig becomes infected through the food supply, by rooting in the mud and by inhaling the immature form in the dust that may accumulate about the sleeping quarters and pens, as a result of the mud carried on the bodies of the animals.

Symptoms.—The disease is largely confined to pigs. The first symptoms begin as a cough, occuring upon leaving the bed, after exercise and after eating. In badly infected cases the paroxysm of coughing is quite severe, beginning slowly and becoming harder and harder, and finally the pig will put the nose on the ground and press hard while coughing. The paroxysm ends by the expulsion of some mucous or by vomiting. This is referred to frequently in the journals as whooping cough in pigs. The cough may become frequent and persistent, and is generally spoken of as chronic. In the majority of cases the infection is so slight that the presence of the lung worm is not suspected by the owner. The appetite

remains good in such cases and the thriftiness of the pig is not interfered with. Death seldom occurs and as the pig grows and thrives, it gradually recovers from the affection.

Treatment.—The most important part of the treatment is to keep the pig in a helthy, growing condition. The hygienic conditions in the pastures and pens should be as nearly perfect as possible. The drinking water should be pure and all ponds and mud holes drained or filled in. Clean watering troughs and feeding floors are also necessary. The sleeping quarters should not be allowed to become dusty. Medicine is of little value in this disease. A fumigation of tar or turpentine may be tried if desired. However, more can be accomplished by feeding a highly nutritious ration, and waiting until age will give the necessary strength and resistance to overcome the disease.

ECHINOCOCCUS, HYDATIDS.

The disease caused by the larval stage of the *Tænia echinococcus* Lieb, is known as hydatid, or echinococcus disease. Dogs and wolves act as hosts for the mature form of this tapeworm, and the immature form is found in domestic animals. It is commonly found in the liver, lungs, etc., of hogs and cattle killed in the abattoir. Man may also act as host for the larval form.

Description.—The larval form appears in the form of cysts, generally in the liver, but they may be found in the lungs, heart and various other organs of the body. After four weeks from the time of becoming infected by the embryo, small cysts about one twenty-fifth of an inch in diameter may be noticed in the infected organs. The outer wall of the cyst is formed by the connective tissue of the organ in which it is located. Within this is the young parasite. Its outer part or capsule is rather transparent, the inside granular and somewhat condensed on the periphary and containing cells which are distinctly separated from one another. The cyst grows slowly and at the end of eight weeks has about doubled in size. The elastic cuticle is then much thicker and its inner surface is covevered by a thin membrane, the germinal layer, which represents the condensed granular contents. In the center of the cyst is a cavity containing

a clear watery fluid. As the hydatid grows, the cuticle becomes stratified and the germinal layer becomes differentiated into small cells occupying the periphery, large cells on the inside and granular cells occupying the

irregular spaces on the surface. At the end of nineteen weeks, the parasite is about two fifths of an inch in diameter. Protuberances gradually grow in to the cavity and develop into broad capsules, and it is in these capsules that the head of the succeeding generation of tape worm develops. Numerous broods of capsules may form in one cyst and many thousand heads may be present in the one hydatid. Several modes or growth are open for the parasite. Centers of growth may form in the wall of the hydatid; these are called daughter cysts. In turn a third generation may form in the same manner in the daughter cyst; these are called grand-daughter cysts. As they develop, they will burst through that part of the hydatid wall offering the least resistance, sometimes on the inside of the wall and sometimes on the outside of it. For this reason they are called endogenous and exogenous cysts. When a group of small hydatids lie close together and are connected by a common stroma, they are called Echinococcus multilocularis. Sometimes as a result of the formation of daughter and grand-daughter cysts, they take on the form of a bunch of grapes; they are then named E. racemosus. Sometimes the

hydatid is headless and consequently sterile. This condition is called Acephlocyst, and does not represent the final larval stage.

The changes in the tissues vary. There may be an enormous increase in the size of the lungs or liver. The serous membrane which covers the

Position of the head in hydatids of the brain.

liver is thickened, and may be joined to the neighboring organs. Its surface is uneven, the salient places corresponding to a cyst. There is an atrophy of the liver cells, the amount of connective tissue is increased and forms a capsule immediately surrounding the parasite; the surface of the capsule, which is smooth and glistening, is entirely separated from the cuticle of the cyst. On section the liver is found to be filled with cavities, with the liver tissue between in the form of small islands or ribbons of various dimensions. In time the cysts degenerate into a caseous or gelatinous mass in which we can find the hooks of the larval tape worm.

Method of Infection.—The hydatids develop as a result of the ingestion of the eggs of the adult tape worm. Dogs infested with the adult worm may scatter the eggs in places where they can infect the food or drinking water of the hog. In countries where dogs are numerous, hogs seem to be more commonly infected, and in the region of slaughter houses where insufficient attention is paid to the destruction of the immature form, dogs may become infested by eating the diseased tissues.

Symptoms.—The symptoms are not characteristic and are frequently entirely absent. When the liver contains a large number of cysts, pressure on the right side of the abdomen just over the organ may cause the animal pain. On percussion we find an increase in the size of the liver. If the increase in size is many times the normal, the abdominal viscera are greatly pressed on, the function of the organ is greatly interfered with and digestive disturbances occur. When the lungs are involved, symptoms of pulmonary tuberculosis may be manifested. If any important organ is severly infested, death may result.

Dropsy as seen in hydated disease of the liver. The appearance in the same when caused by other liver affections.

Treatment.—Preventive treatment is of the utmost importance. It consists in destroying all organs infected with hydatids. Dogs known to be infested with the adult taenias should be destroyed. It is dangerous to keep dogs in this condition, as man as well as pigs may become infected. If such precautions were used, the disease could be finally exterminated. This disease is apparently on the increase in this country.

THE LIVER FLUKE.

The common liver fluke, *Fasciola hepatica*, Linn, is more common in cattle and sheep than it is in hogs. Liver flukes are apparently of little importance in hogs in this country. They may affect other organs besides the liver, but this is the chief abode of the parasite. It is generally found in low lands and is more prevalent on wet than on dry years.

Description*.—Fasciola hepatica, L. Body; pale brown, leaf like, flattened, 18-15 mm. long by 4-13 mm. broad. The anterior 3-4 mm. forms a rather thick, conical portion which is followed by a large flat, leaf-like body of elongate, oval form; this latter widens rapidly to the maximum breadth, and then decreases gradually in width to the posterior end which is bluntly pointed; cuticle is covered with numerous spines placed side by side in alternating rows; oral sucker is anterior, round and terminal, but inclines ventral; acetabulum about 3-4 mm. caudad of oral sucker, with which it closely agrees in size; genital pore median, about half way between oral sucker and acetabulum; oesophagus rarely over 1-1-½ times as long as the pharynx; intestine dentritic; cirrus frequently extended from pore and then recurved; testicles profusely branched, situated for the greater part posterior to transverse vitello-duct. Vulva is at side of cirrus; uterus forms a rosette with its numerous coils, and is frequently visible to the naked eye as a dark-brown spot, immediately posterior to the acetabelum; ovary branched, anterior of transverse vitello duct; vitellogene glands profusely branched, and occupy the entire margin of the body from acetabulum to posterior extremity; they lie dorsally as well as ventrally of the intestine, becoming wider posterially. Oviparous.

Eggs; oval, 0.13-0.14 mm. long by 0.075 to 0.09 mm. broad; miracidum conical, ciliated with oval papillae, two cup shaped eye spots, rudimentary intestine; metamorphosis (sporo cyst, redia, cercariae) take place in small snails of the genus Linneae; (L., trucatula, and others.) Cercaria whitish, owing to excessive development of capsule glands; encysts upon plants.

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*Stiles, Ch. Wardell and Hassell, Albert—

Journal of Comparative Medicine and Veterinary Archives, XV. pp. 302 ,1894.

Life History of Fluke and Method of Infection.—Although the life history of fluke is of little importance to us at present, it is well for us to know something about their development. Their life history in brief is as follows: Each adult worm is capable of producing an immence number of eggs (thirty seven to forty five thousand.) These pass down the billiary passages into the intestines and become mixed with the faeces. Those that reach some favorable place for development after a long or short period of incubation (from ten days to three months) depending on the amount of heat and mositure, become a ciliated embryo. The ciliated embryo (Miracidium) swims around in the water and seeks certain snails (Linnea trucatula, L. oahuensis, L. rubella), penetrates into the respiratory cavity of these animals and encysts. The sporocyst, which it is now called, at the end of about fourteen days is about one fiftieth of an inch in length, and the germ cells present develop into a third generation, known as rediae. The rediae escape from the sporocyst when the latter is from two to four weeks old. They then wander to the liver of the snail and from the germ cells present in the body cavity of the parasite develop the next generation, the cercariae. This latter form resembles the adult parasite. It may remain in the body of the snail for some time or pass out and attach itself on the grass or acquatic plants around the margins of the pond and encyst. The different animals become infected from eating these snails along with the food, or from eating grass infested with the cercariae. The development will last from ten to twelve weeks. Each sporocyst may give rise to from five to eight rediae, and each rediae to from twelve to twenty cercariae.

Lesions and Symptoms.—These are directly dependent on the presence of the flukes in the body, and as the liver is the organ generally affected and the chief abode of the parasites, the principal lesions are in this organ. The flukes are confined to the gall ducts, but may pass out into the proper tissue of the liver. There is a catarrhal inflammation of the bile ducts. The smaller ones may become dilated and form cysts. The inflammatory processes extend from the ducts to the connective tissue of the liver and it becomes hypertrophied, and the liver cells are destroyed to some extent, depending on the amount of infection, and a large portion of the liver is a mass of cicatritial tissue. The gall is changed in character,

is less thick, greenish brown or dirty red in color and contains liver cells blood cells, etc.

These changes in the liver and in other organs as well, lead to changes in the body nutrition and the animal may become anemic, weak and emaciated.

THE LUNG FLUKE.

The lung fluke, *Paragonimus Westermanii*, is sometimes found encisted in the lungs of hogs killed in the abattoir. Dr. A. J. Payne, chief inspector in charge at Cincinnati during the latter part of 1898, found one per cent. of the hogs killed in the abattoir affected with this parasite. The hogs were in good condition and only a few cysts were found in each lung. The muscle flukes in American swine are probably young specimens of the lung fluke.

Its complete life history has not yet been determined, but according to present knowledge the worm does not develop until after it leaves the host in the sputum. Some observers have succeeded in raising the embryonic stage, but beyond this nothing positive has been demonstrated. This worm has been found in man, cat, dog, tiger and hog.

PORK MEASLES.

Measles of the pig is a parasitic disease caused by the *Cysticercus cellulosæ*, Rud, a larval form of the Taenia solium, a tape worm sometimes found in man. The frequency of measles corresponds with that of the tape worm, as the pig becomes infected by eating human excrements which contain segments of this parasite.

The bladder worms or cysticerci are found in the muscular tissue, especially in the region of the abdomen, in the tongue, heart, neck, shoulders, pelvis, flank and superior regions of the legs. They may be found in other organs as well. The adult cysticerci represents a small vesicle about the size of a pea or bean, of a dull white color and provided with a head and neck. This is marked externally by a dark spot which is bent in toward the inside of the vesicle.

Method of Infection.—Man harbors the adult worm, Taenia solium, and hogs become infested with the larvae by taking into the digestive tract the segments of the parasite that are passed out with the faeces. These contain a large number of eggs and on reaching the stomach are

freed from their shells by the dissolving action of the gastric juice. The embryo is then free, perforates the intestinal wall, or enters a small blood vessel and drifts along in the blood stream until it reaches a suitable place to develop. Nine days after infection a small oval vesicle forms in the infested tissues. In twenty days, the bladder worm is about as large as the head of a pin, and in sixty days it has grown to about the size of a pea. It is then enclosed in connective tissue and has fully developed, and at the end of this period a well formed neck can be seen.

Degenerative changes take place quite early. The connective tissue capsule becomes infiltrated with lime salts, and gradually the whole parasite undergoes a calcareous degeneration.

Symptoms.—There are no definite symptoms. Some investigators have described as symptoms of measles, a hoarse voice, falling out of the hair, depression, loss of appetite, weakness, emaciation, a partial paralysis, diarrhoea and oedematous swellings in the region of the head, neck and shoulders. A more postive diagnosis may be made by examining the visible mucous membranes of the mouth, especially in the region of the tongue, for the characteristic lesions. When the tissues in these parts are affected, small pimples may be felt or seen on the mucous membrane. Blindness, rabiform symptoms, etc., have been reported in cases of general infestion of the tissues, and within a variable time exhaustion and death.

Treatment.—This is wholly preventive. Pigs should be prevented from ingesting the fecal matter of man by using proper precautions.

The importance of this parasite lies in the danger of man becoming infested with the adult worm. The Taenia soleum is an armed tape worm and gives rise to much more serious symptoms than the more common unarmed form. The infection results from the eating of uncooked pork. Man may also become infested with the cysts. This may occur in various ways; as a result of a reverse peristalis of the intestine carrying a gravid segment into the stomach, from a contaminated water supply and from the hand becoming soiled at the time of defecation. In man the bladder worm may develop in the eye or brain, and give rise to very serious symptoms.

The preventive treatment consists in tanking the parts infested with cysts and eating only well cooked pork.

BLADDER WORMS.

The bladder worm, *Cysticercus tenuicollis*, Leuck, is another tape worm larvae occurring in the body cavity of swine. It is also found in cattle and sheep. The adult tape worm, *Tænia marginnata*, Batsch, is found in dogs and wolves. These bladder like bodies are a half an inch or more in diameter and are usually found on the folds of the omentum.

Method of Infection.—The eggs of the Taenia marginata pass out with the excrement of dogs and become scattered around on the ground. Infection takes place the same as in some of the other parasitic forms, the egg containing the six hooked embryo entering the digestive tract along with the food. The embryo on reaching the stomach and intestines is liberated by the digestive juices. It then migrates from the intestines, either by crawling or by drifting along in the blood until it reaches the liver. About four days after infection, it can be seen in this organ, lodged in the finer branches of the blood vessels which it transforms into tubes, and having the appearance of a small round kernel. After remaining here for a short time, it leaves the liver and falls into the body cavity and usually encysts on the omentum. Here it remains until fully developed, which requires several months. In time, as is the case with the cysticercus, it undergoes degenerative changes. If the cyst is eaten by a dog the scolex or head is freed from the cyst by the digestive juices, and the suckers and hooks attach themselves to the wall of the intestine and development of the segments of the tape worm begins.

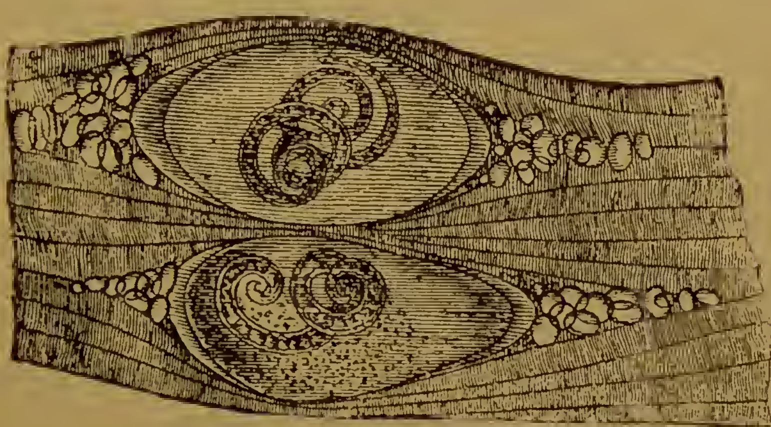
Symptoms.—The symptoms produced by the bladder worm are not noticeable. No deaths have ever been reported in hogs from infection by this worm. When the infection is heavy, inflammation in the body cavities as a result of the migrations of the larvae may occur, but the symptoms manifested by the animal are not diagnostic. It is hardly possible to recognize the disease in the living animal, and if it could, the treatment would not differ from that recommended in peritonitis and pleurisy.

The lavrae of the Taenia marginata is not of as much economic importance as the larvae of the Taenia soleum. It does not cause as serious a line of symptoms in its host as the cysticercus, and does not infect man.

TRICHINOSIS OF THE PIG.

Trichinosis is a disease caused by the muscles of the body becoming infested with a very small round worm, the *Trichina spiralis*, Owen. The disease is seen in man and other mammals. It occurs in two forms in the one animal; the intestinal, which represents the adult parasite, and the muscular, which represents the larval stage of the parasite. From one to three per cent. of the pork examined contains trichina.

Description and Life History.—The adult T. spiralis is a very small worm. The male a little over one twenty fifth of an inch long, the female about three times the length of the male. The digestive tract can be divided into a buccal opening, oesophagus, stomach, intestines, anus and



Trichina in the muscle. From Neumann.

cloacal slit. The genital apparatus in the male consists of testicular tube, excretory canal and genital orifice; in the female of ovaries, uterus, vagina and vulva. Internal impregnation takes place, and the eggs develop in the uterus of the female to the number of at least a thousand and are born alive. These embryonic worms within a short time after birth penetrate through the walls of the intestines and migrate through the tissues until they reach the involuntary muscles. It then enters the muscle fibre, coils itself up and rests. In about two weeks, the cyst can be seen and embryos become transformed into larvae. The tissue in the neighborhood of the embryo, is the seat of cellular infiltration, and the muscles in the region may become swollen, and undergo more or less degenerative changes. Connective tissue forms in the region of the parasite and the cyst containing one or more larvae, is spindle or lemon

shaped. The larva is about one twenty-fifth of an inch in length. The formation of the embryos begin about the seventh day after the cysts are taken into the digestive tract. The emigrating period is prolonged to the second or third week, and the encysting period from the fourth week to the third month. After the third month degenerative changes begin in the cyst and finally involve the larvae as well, but these changes (calcareous degeneration) may take place very slowly and not occur for a year or more. When the cyst does become calcified, danger to the infested individual is over. One ounce of the flesh of an infested pig may contain eighty five thousand encysted worms.

Method of Infection.—Infection occurs from eating flesh containing the live larvae of the T. sprialis. The source of the infection in swine is from eating rats. According to the investigations made by Stiles, rats around the country slaughter houses are quite generally infested with trichina, as it is rare to find the offal in country disposed of in the proper way, and rats are abundant around such places. Hogs frequently have the same opportunity as the rats to feed on offal and under such conditions infection may occur.

Symptoms.—These have been observed in experimental animals and in man. When only a few embryos migrate through the tissues, but little body disturbance is noted. The disease is characterized by two groups of symptoms; one affecting the intestinal canal, the other the muscles.

From the beginning of the first to the end of the second week after infection, gastro intestinal disturbances are noticed, but the symptoms are not constant. The appetite is lost, the hog is depressed, abdomen tense and the animal may vomit. Colicy pains accompanied by a diarrhoea may occur. When the parasites are present in large numbers, it may lead to a rapid death, but if only a few are present the sympotms of disease may end in this stage.

The muscular symptoms are due to the inflammation caused by the migration of the parasites. They are observed from the second to the third weeks. The pig may rub and scratch itself, symptoms resembling rheumatism occur, and the animal is stiff, sometimes paralyzed. Respirations are difficult, it can hardly masticate and swallow its food, and the voice is much changed. Oedematous tumifactions may appear in various

regions and the pig loses flesh very rapidly. Pigs generally recover in about five or six weeks.

Treatment.—The treatment is preventive. The offal around slaughter houses should be disposed of in the proper way. Hogs should not be allowed to eat this refuse and if kept around abattoirs at all, should be fed grain. If the symptoms of the disease are marked and a correct diagnosis can be made, all that can be done is to destroy the animal. As this disease is communicable to man and is often followed by fatal results, only well cooked or well cured pork should be used as food. It is impossible for the parasite to survive the proper cooking or curing of the meat.

IMMUNITY.

The subject of immunity and immunization is of so much interest to swine breeders that the addition of a special article setting forth the basic principles seems to be demanded.

Immunity is the power of resistance which every form of life posses against injury or destruction by some other form. The term is used almost wholly in the sense of expressing a resistance of an individual to disease. It is an inherent quality in all animal or plant life. It varies in the different species toward the same cause and in individuals of the same species toward different causes. The term is no longer applied to the resistance of the individul to some organism, but is made to include the products or toxines produced by the organism. Immunization is the process by which the resistance may be increased towards any particular form of organism.

The difference in immunity in the different species towards the same cause is easily illustrated by a comparison of the diseasess occuring in the human subject and in the lower animals. In the human, we have cholera, typhoid, and yellow fever, that are never found in other species. The lower animals therefore possess a very high degree of immunity toward these diseases. In swine, we have swine plague that never occurs in the human. In cattle, we have southern cattle fever that does not effect any other species. We have other diseases as tuberculosis and glanders that may effect the human and some of the lower forms. There are some

diseases of the human that have not been successfully inoculated into the lower animals and likewise diseases of one specie that do not occur in another. An individual or a specie may have a very strong natural immunity against a given form, but by exposure under adverse conditions or by inoculation, my become affected.

Immunity is therefore only a relative term and is not absolute. It is said to be strong or weak as measured by the degree of resistance under ordinary conditions.

Age is an important factor in natural immunity. The young as a rule offer a lesser degree of resistance to infectious diseases than do the old, while the latter show a greater susceptibility to chronic affections. This can probably be best illustrated from examples in the human subject. Children are prone to have measles, scarlet fever, chicken pox, "mumps," and these are commonly known as children's diseases. A person may contract one of these diseases when they have arrived at maturity but the chances of doing so are very greatly reduced. This is often ascribed to the fact that most persons have these troubles when young and therefore are protected against a second attack. The fact remains, however, that among persons who have escaped these diseases while young, the power to resist an attack is greater than in the average child. To draw a like illustration from the lower animals, we may cite the fact that sore mouth and joint diseases occur in very young pigs, cholera principally among the young, and pigs that are half grown, while swine plague attacks half grown and older animals. It is not meant to convey the impression that these diseases may not occur at any age but the large preponderance of all cases do occur at the time indicated, and that there is a difference in resistive power at different ages independent of the effect of previous attacks.

Effect of previous attacks.—Immunity results from an attack of some diseases. We can divide diseases into two classes upon this basis, those which do not tend to occur after one attack and those in which the tendency is but little or not at all diminished. In the diseases of the first class there are changes which take place in the body that protect it for a greater or less length of time, and in some, as long as the subject lives. In the second class these changes are so slight that they have only a temporary if any effect. The immunity thus acquired is not necessarily due

to changes caused by the presence of the disease germs but may be due to the products which they produce. The products of the disease germs are called toxines. That the immunity which results from an attack of some diseases is due to these poisons and not to the presence of the germs can be easily demonstrated. The germs may be grown in a suitable medium, as boullion, and after they have grown some time the material may be filtered and heated so there will be no living germs present. This material will contain the toxine or poison produced by the germ, and if injected into the body of a suceptable patient, first in small, and then gradually increasing doses it will be found that the patient will acquire immunity the same as that following an attack in the usual way. In this instance there has been no disease germs and yet immunity results. The body has formed the same protective products to neutralize the poison introduced artificially as would have occurred if they had resulted from the growth of the germs in the body. In the second class of diseases there are no protective products formed, or if there are, they are too weak to be effective.

It must also be borne in mind that different diseases attack the body in different ways and that the protective powers also differ. Some produce their effect through a poison or toxine as already cited, and the resistance comes from the antitoxine formed. The two best known and most thoroughly studied diseases of this type are diphtheria, and tetanus or lockjaw. Both the toxine and antitoxine are so well known that the latter is extensively used in the protection and cure, especially for diphtheria. Some diseases affect the body through the enormous multiplication of the germs. In this type there may be a product formed which tends to arrest this multiplication, or there may be special destructive activity on the part of certain cells, especially the white blood corpuscels. The product which tends to prevent multiplication is known as a bacteriolysin. Bacteriolytic products are not so well known as antitoxines and not so successful in use. That most employed in medicine is antistreptococcus serum in the treatment of blood poisoning.

The immunity gained as the result of an attack of a disease, whether it be antitoxic, bacteryolitic or both, is a natural acquired immunity.

In the case of hog cholera we do know that a certain amount of immunity is acquired. A brood sow that has successfully withstood an at-

tack of disease has an enhanced value because of the fact. The immunity which she has acquired is not transmitted to her offspring. It is an exceedingly desirable quality to be obtained in all, occurs in nature in so few, and at such great price that every known artificial method has been employed to induce it. These will now be considered in some detail.

Vaccination.—Since immunity results from an attack of some diseases and the immunity gained from a mild attack is protective the same as for a severe attack, attempts have been made to induce a mild form for protection. This was first done in connection with small-pox. The patient was dieted and put in as healthy condition as possible and then virus was taken directly from an afflicted patient, care being exercised to select one suffering from a mild form of disease. This had the desired result in many cases but often caused death. Virus taken from a mild case might suddenly acquire increased virulence with fatal results. Later, it was discovered that patients vaccinated with cow-pox in a natural way in handling cattle were immune to smallpox, or that those suffering from the cow-pox had it in a very mild form compared with those vaccinated with small-pox. This led to the abandonment of the human virus and the substitution of the bovine material or cow-pox. Sepsis and other serious complications often resulted at first but the method of preparing the virus, preserving, and using it, have been so greatly improved that it is now used with a feeling of safety. We now know that the cow-pox and small-pox are the same diseases, but the passage of the disease through the cow reduces its virulence for the human subject. Furthermore we know the immunity gained by the bovine virus is not so strong or so enduring as that from the human. The operation of vaccination consists of abrading or scratching the surface of the skin and rubbing in the virus. Vaccination has been tried for the prevention of hog-cholera and swine plague but without the degree of success that is essential in practice. The virus taken from infected hogs is not so satisfactory, and there is no other animal known to have the disease so that it may be modified by passage through a different body. Attempts to modify the virus by artificial means has also been a failure.

Innoculation.—Immunity may also be acquired by artificial means by a method popularly known as innoculation. In this method the virulence of the germs are reduced by artificial means. It has its best application

in the prevention of blackleg. The tissues of an animal having died of blackleg are heated to such a degree as to nearly destroy all germs. A bit of tissue is then rubbed up with some sterile water, filtered and injected into a susceptable animal. The innoculation has the effect of producing a mild form of the disease which will suffice to protect against a natural infection. In localities where the danger is great, an innoculation is first made with material that has been heated to a high degree, and after ten days again innoculated with material that has been heated to a lesser degree, but which if used in the first case would cause serious illness and possibly death in many cases. The first inoculation produces a slight immunity and the second greatly increases it.

Heating is not the only method of decreasing or attenuating the virulence of germs. It may also be accomplished by growing them in different media, and at different temperatures for different periods of time, and by chemicals. All of these methods have been employed in securing a virus for protecting against hog cholera, and like vaccination, without success except in a comparatively limited number of cases. Both vaccination and innoculation are objectionable in that living germs are employed and in the event mild cases are induced the germs will be passed from the body, and may become the center of infection for an epidemic in a herd or neighborhood.

Inoculation differs from vaccination in that the material is placed directly into the tissue of the body with a hypodermic syringe and not by scratching the surface.

Inoculation is also made by taking blood from an animal suffering with the disease and injecting it into a susceptible animal. This is the method used in immunizing against southern cattle fever. The dose is small. Attempts have been made to use the sterile serum from affected animals but without success. In the case of southern fever the hypodermic syringe takes the place of the tick, which does the same thing under natural conditions. By the artificial method the size of the dose is regulated. The same method has been tried with hog cholera.

Feeding.—Immunity may also be acquired by feeding small quantities of germs that have had their virulence reduced. The quantity and virulence are both gradually increased until the animal can successfully withstand what would ordinarily produce a serious or fatal illness. This

method has been found successful in some experimental work and is used by a few breeders with apparent success. This is in reality at the basis of a method that has received a great deal of attention in the past few years. It was accomplished in a crude way by feeding swine on pieces of the carcass of one that had died of cholera. The quantity was gradually increased and the period between the feedings shortened. The animals selected for the purpose were generally old ones whose resistance were already strong. Its use was especially rcommended for breeding sows near the time of farrowing, as it was believed that immunity would result in utero. The process was continued after farrowing to intensify the immunity through the effect on the mother's milk. The natural product not being always available and necessarily of variable character, cultures of the germs were soon substituted. As the practical application of this method is conducted on a commercial or trade basis, little is known of the uniformity of the virulence of the germs. It is even more objectionable than vaccination or inoculation in that there is sure to be infection of the premises, and the possibility of making a center for an epidemic. The principle involved in this method is not a new one, it is only the application in a commercial way and the extensive advertising that has attracted attention.

Dead Cultures.—It has been found in the course of many experiments with disease germs that immunity may be acquired in some cases after the injection of dead germs. For this purpose, the germs are usually grown upon some solid media like agar agar, and when they have made a good growth, they are scraped off, dried and killed at as low temperature as possible. The germs are then macerated in sterile water and injected as in inoculation. This has been tried in almost every conceivable way, using all known, and I might say, almost all unknown media and at different temperatures. The material prepared after this manner is frequently called antitoxin and used for immunizing purposes. It is not a true antitoxin and does not cure nor prevent in the same way as antitoxin. There is probably some merit in the method the same as may be said for all. It has not been perfected to such a degree that it can be recommended.

In all the foregoing methods the object has been to develop in the body a substance or substances, that will act as a protective agent for a

considerable period of time. The object sought has been to produce such a mild form of the disease that a second attack will not occur even though an epidemic be present in the community. The immunity that would thus be acquired would be active. There still remains two other methods of securing immunity.

Antitoxin.—In some diseases, the marked effects upon the body are due to the poison which the germs produce and not to the number of germs present. This is notably true of diphtheria and tetanus. After both of these diseases, we find that the blood of the patient contains a substance known as antitoxin and has the power of neutralizing the toxine produced by the bacteria. This substance is so strong that blood may be taken from such a patient, and if the serum be injected into the body of a patient exposed to the disease, or found to be diseased, it will prevent or greatly lessen the severity of the attack. We take advantage of this fact, and use the antitoxin in a very large percentage of cases with better results than any other known treatment. In making antitoxin for the treatment of diphtheria, the horse is selected for providing the serum. A healthy animal is inoculated with a small dose of the toxine and as soon as it makes a recovery, a little larger dose is given. This is repeated at short intervals for a period of from six to eight weeks. At the end of this period the animal will be able to stand a dose a hundred or more times greater than would have been tolerated at the first inoculation. The blood of such an animal will possess an enormous mimunizing power. When used upon the patient however, it simply adds that property to the blood and does not cause its development in the body. The immunity conferred only lasts for a short time, from four to eight weeks, or long enough to pass over a period of infection. A similar line of work has been done in connection with hog cholera and swine plague. The results have been interesting from a scientific standpoint rather than the practical. The cost in developing the serum, the care needed in its application, and the short period of immunity conferred have all been against it. It was used in the government experiments, but only a few firms ventured into the production upon a commercial scale, and none are in operation as far as known to the writer.

Toxine Method.—In this method the germs of the disease are grown in a suitable media like beef boullion, and when they have produced about

all the poison they will, they are then filtered off and the poison is injected, first in a small and then in a large dose thus stimulating the body to produce its own antitoxin. This is the method used in developing a strong antitoxin in the horse's blood aginst diphtheria, but it is not practical in its application to the treatment of millions of hogs on the farm.

Antibactericidal sera.—A bacteriolytic serum is used in the treatment of septicaema or blood poisoning. This serum has the effect of greatly increasing the destructive powers of the normal serum of the blood. This acts differently from the antitoxin. Instead of being direct, its effects are indirect. Theoretically it would seem that such a serum would be indicated rather than an antitoxine. Experimentally however, the proper or effective serum has not been found.

We are familiar with the results obtained by several veterinarians with the use of the different antitoxines upon the market, and they have not been of such encouraging character as to warrant their general use. There are firms that use purely chemically compounded preparations under the name of antitoxine, but as they are misnomers and intended to mislead. They have no place in this discussion.

HOG CHOLERA AND SWINE PLAGUE.

INTRODUCTORY.

The annual losses from hog cholera in the United States are unquestionably very heavy, for, although all diseases of swine are called cholera by people not familiar with them, scientific investigation has confirmed the opinion of our farmers that we have a widespread and destructive plague to which the term hog cholera may be appropriately applied. The researches of the Bureau of Animal Industry, conducted in the most thorough and systematic manner and with the aid of all the appliances of modern science, have shown that there is another disease, called swine plague, which appears to be almost as common and fatal as hog cholera.

These two diseases resemble each other very closely in their symptoms, and it requires an examination of the internal organs after the animal's death, and in many cases a microscopical study, to clearly distinguish between them. Fortunately, we are able to formulate methods for the prevention, cure, and eradication of these diseases which may be applied with the same success to both. Hog cholera and swine plague are not only similar in symptoms, but in their effect upon the bodies of the affected animals. They resemble each other in that both are caused by bacteria; they must be combated by measures which will prevent exposure to these bacteria or destroy them after they have been introduced upon the premises, and the sick animals must be treated by remedies which will reduce the fever, stop the multiplication of the germs, and assist the affected organs in resuming their normal functions.

The difficulty of distinguishing between the two diseases is, therefore, of no great consequence in the practical work of controlling them. It is important to know that one or the other of these maladies is present, because this knowledge leads at once to the adoption of the measures applicable to the treatment of infectious diseases. Knowing that we have either hog cholera or swine plague to deal with, we are safe in carrying into effect the treatment recommended in this bulletin, because the agents which destroy one of these germs will generally destroy the other.

sisting to the end. The eyes are at first congested and watery, but soon the secretion thickens, becomes yellowish, accumulates in the angles and gums the lids together. The breathing is more rapid than usual and may be oppressed and labored in the later stages. There is a cough, which, however, is not very frequent, and generally heard when the animals are driven from their bed. It may be [illegible] dry cough, or it may be paroxysmal. The skin is often congested and red over the abdomen, inner surface of the limbs, under surface of the neck, and on the ears. The color varies from a pinkish red to dark red or purple. An eruption is sometimes seen, which leaves crusts or scabs of various sizes over the skin. There is rapid loss of flesh, the animal grows weak, stands with arched back and the abdomen drawn up, and walks with a tottering, uncertain gait. There is less and less inclination or ability to move, and the weakness and exhaustion increase until death results.

The symptoms of swine plague in many cases are not noticeably different from those of hog cholera. Frequently, however, the lungs are extensively inflamed in swine plague, and in that condition the breathing is more oppressed and labored, and the cough more frequent and painful.

The course of these diseases varies from one or two days to two or three weeks.

APPEARANCES ON POST-MORTEM EXAMINATION.

The germs of hog cholera have a habit of collecting or growing in clumps in the blood vessels, which leads to a plugging of the smaller vessels, with frequent rupture and escape of blood. This causes red spots where the blood leaves the vessels and collects in the solid tissues. These spots are variously referred to as petechiæ, ecchymoses, hemorrhages, and extravasations of blood. They are common in hog cholera for the reason given. In swine plague the bacteria are evenly diffused through the blood, never form plugs, and therefore hemorrhages from this cause are not seen.

In the most acute forms of hog cholera the changes seen in the various organs consist principally of these red spots caused by hemorrhages of greater or less extent.

The spleen is generally enlarged to from two to four times its normal size, is soft, and engorged with blood.

The blood extravasations are frequent in the lymphatic glands; beneath the serous membranes of the thorax and abdomen, and particularly along the intestines; on the surface and in the substance of the lungs and kidneys; on the mucous surface of the stomach and intestines; and in the connective tissue beneath the skin. The contents of the intestines are sometimes covered with clotted blood.

The diseases of Europe which appear very closely related to our swine plague (*schweineseuche*, *wildseuche*) also have a hemorrhagic form,

but this has not been observed in America, although hemorrhagic inflammation of the stomach and intestines has been seen in swine plague. Cases of swine plague with external swellings caused by an infiltration of yellow lymph in the subcutaneous connective tissue, generally of the neck, have been seen, but are rare in this country.

The subacute and chronic forms of hog cholera and swine plague are more common. In this form of hog cholera the principal changes are found in the large intestine and consist of ulcers which appear as circular, slightly projecting masses varying in color from yellowish to black. Occasionally these ulcers are slightly depressed and uneven in outline. When cut across, they are found to consist of a firm, solid growth extending nearly through the intestinal wall. They are most frequent in the cæcum, upper half of the colon, and on the ileo-cæcal valve.

In the chronic form of the disease the spleen is rarely enlarged; the lymphatic glands of the affected intestine are enlarged and tough. In the more acute cases lung lesions may be found, varying from collapse and œdema of the lung tissue to broncho-pneumonia.

In swine plague the lungs are often found inflamed, and to contain large numbers of small points, which may be made out by loss of color, where the life of the tissue has been destroyed (necrotic foci). There may be also found in the lungs large cheese-like masses from 1½ to 2 inches in diameter. Inflammation of the serous membranes is very common in swine plague, and this may be found affecting the pleura, pericardium, and peritoneum, accompanied with fibrinous, inflammatory deposits on the surface of these membranes. There may be congestion of the mucous membrane of the intestines, particularly of the large intestine; or the disease in this region may be more intense and lead to a croupous inflammation with the formation of a fibrinous exudative deposit on the surface.

In hog cholera the first effect of the disease is believed to be upon the intestines, with secondary invasion of the lungs. In swine plague the first effect is believed to be upon the lungs, and the invasion of the intestines a subsequent process.

Briefly reviewing these changes, we find that the most characteristic lesions of hog cholera consist of:

(1) Hemorrhages, particularly in the subcutaneous, submucous, and subserous connective tissue; in the lymphatic glands, and in the various organs of the body.

(2) Ulcerations of the large intestines.

(3) Collapse of lung tissue, and, less frequently, broncho-pneumonia.

The most characteristic lesions of swine plague are:

(1) Inflammation of lungs; numerous small necrotic points in these organs, or a few larger cheesy masses.

(2) Inflammation of serous membranes with fibrinous deposits.

(3) Congestion of mucous membrane of intestine, or inflammation of the same with fibrinous deposits.

Notwithstanding this clear difference in typical cases, there are many outbreaks where it is difficult to make a diagnosis even after post-mortem examination, because both diseases may be affecting the same animal at the same time, or the changes may resemble both diseases without being very characteristic of either. In such cases it is only by microscopic examination and cultivation of the germs that a reliable diagnosis can be made.

THE CAUSE OF THESE DISEASES.

Both hog cholera and swine plague are caused by bacteria, which have now been so carefully studied that they may be easily identified by persons accustomed to bacteriological researches. The hog-cholera germs are slightly larger and more elongated than those of swine plague; they are provided with flagella, or long thread-like appendages, which enable them to move rapidly in liquids; while the swine-plague germs have no such organs, and are unable to move except as they are carried by the liquid in which they float.

Hog-cholera bacteria, when inoculated in minute doses, are fatal to mice, rabbits, and guinea pigs, and in large doses may kill pigeons. Swine-plague germs are fatal to these animals and also to fowls.

Hog cholera may be produced experimentally (1) by exposing well hogs to diseased ones in the same pens; (2) by feeding the internal organs of diseased carcasses or cultures of the germs; (3) by hypodermic injection of cultures of the germs in doses of one-half to 1 cc. or greater.

Swine plague may be produced experimentally (1) by cohabitation; (2) by injecting cultures of the germs into the lung tissue.

In some outbreaks the swine-plague germs may produce the disease if they are injected hypodermically, but as a rule the swine plague of this country can not be communicated in that way. Cultures of the bacteria of swine plague have been fed to hogs, and have been sprayed into the air which they were breathing, without causing the disease.

Both diseases are produced by injecting cultures of their respective germs directly into the blood vessels.

From the results of experiments with these diseases it has been concluded that the germs of hog cholera find their way into the bodies of swine principally with the food and drink and with the inspired air; while those of swine plague are taken almost entirely with the air, or, at least, they almost invariably gain entrance through the lungs.

Hog-cholera germs are very hardy and vigorous. They are able to multiply and live for a long time in the water of ponds and streams; they may live in the soil for at least three months, and in accumulations of straw and litter for a much longer time; they withstand drying and other adverse conditions in a remarkable manner.

The swine-plague germs, on the contrary, are very delicate and easily destroyed. They soon perish in water or by drying; the temperature for their growth must be more constant and every condition of life more favorable than is required for the hog-cholera germs. The swine-plague germs are widely distributed in nature and are probably present in all herds of swine, but they are not deadly to these animals except when their virulence has been increased or the resistance of the animals diminished by some unusual conditions. The hog-cholera germs, on the contrary, are not usually present and must be introduced from infected herds before this disease can be developed. The swine-plague germs may acquire sufficient virulence, by encountering proper conditions on one farm, to spread to adjoining farms in the same manner as hog cholera. There are, hence, practically the same conditions to guard against in the prevention of the two diseases.

DIAGNOSIS.

The first question that occurs to the owner of swine when disease appears among his animals is, What is the disease with which they are affected? It is important to briefly consider in this place the nature of the evidence upon which this question is to be answered.

If several animals are affected with the symptoms already enumerated, and if the same disease has been affecting the hogs on neighboring farms, we may decide that one or both of the diseases in question are present, since no other epizootic disease has been recognized in this country.

In anthrax districts there may be occasional small outbreaks of that disease, in which there is great inflammation and swelling of the tongue (glossanthrax), or of the throat (anthrax angina), or simply a fever with no local swellings. If the disease is anthrax, other species of animals, horses, cattle, and sheep, will also be affected.

If, on examining the carcass after death, projecting button-like ulcers are found in the large intestines, we know that hog cholera is present. It must be remembered, however, that these ulcers are not found in the most acute cases, but only in the subacute or chronic form of the disease where life is prolonged a sufficient time for them to form.

If there is inflammation of the lungs and particularly if cheese-like masses are found in the substance of these organs, the disease is probably swine plague.

Small blood spots in the tissues or scattered over the internal organs indicate hog cholera, while inflammation of the serous membranes indicates swine plague.

A bacteriological examination is the final test, but neither this nor inoculation experiments are available to the farmer, for whose use this bulletin is prepared.

PROGNOSIS.

The losses which result from outbreaks of hog cholera and swine plague depend partly upon the condition of the hogs—that is, upon

their susceptibility to the disease—and partly upon the virulence of the contagion in the particular outbreak. If the animals are very susceptible and the contagion very virulent, the loss even in large herds may reach 90 to 95 or even 100 per cent in those cases where the disease is allowed to run its course. In milder outbreaks or with animals more capable of resisting the contagion the losses vary from 20 to 60 per cent. Toward the end of an outbreak a larger proportion of animals will recover than at the beginning. A portion of those recovering will fatten, but others remain lean, stunted in their growth, or never become really healthy animals.

THE TREATMENT OF HOG CHOLERA AND SWINE PLAGUE.

Can hog cholera be cured? and, if so, what remedy will restore the diseased animals to health? These are the first questions asked by the swine-grower, and to his mind this should be the objective point of all investigations. With all diseases of this class, however, prevention is cheaper and in every way more satisfactory than medical treatment. The great aim of the Goverment and the farmers should be, therefore, to prevent the spread of infectious diseases. Every swine-grower should use the utmost precautions to prevent the introduction of these plagues into his herd. In spite of such preventive measures many herds will become infected. Until the Federal Government or the individual States enforce measures of eradication, it is, consequently, legitimate to ask and to answer the question as to the proper medical treatment.

Before formulating this treatment it should be explained that a remedy which will cure every case is not to be expected. There has never been discovered a remedy for a single one of the infectious diseases of man or animals which will cure every individual attacked. Some forms of these diseases are so violent and rapid that the animals are dead almost before they are observed to be sick. Under such conditions there is not time for the most active remedy to produce a beneficial effect.

In many outbreaks the type of the malady is less virulent and there is time to treat the animals after they are sick, and also the whole herd after some members of it have shown that they are diseased. For a long time after beginning the investigations of the infectious diseases of swine, the writer was doubtful if any remedy or combination of remedies could be made which would produce any marked effect. The experiments of the last year, however, indicate that treatment if properly applied may be successful. With the assistance of Dr. E. A. de Schweinitz, chemist of the Bureau, and Dr. V. A. Norgaard, inspector, a number of formulas have been developed and used in the field with good results.

The most efficacious formula which has been tried is the following:

	Pounds.
Wood charcoal	1
Sulphur	1
Sodium chloride	2
Sodium bicarbonate	2
Sodium hyposulphite	2
Sodium sulphate	1
Antimony sulphide	1

These ingredients should be completely pulverized and thoroughly mixed.

The dose of this mixture is a large tablespoonful for each 200 pounds weight of hogs to be treated, and it should be given only once a day. When hogs are affected with these diseases they should not be fed on corn alone, but they should have at least once a day soft feed, made by mixing bran and middlings, or middlings and corn meal, or ground oats and corn, or crushed wheat with hot water, and then stirring into this the proper quantity of the medicine. Hogs are fond of this mixture, it increases their appetite, and when they once taste of food with which it has been mixed they will eat it though nothing else would tempt them.

Animals that are very sick and that will not come to the feed should be drenched with the medicine shaken up with water. Great care should be exercised in drenching hogs or they will be suffocated. Do not turn the hog on its back to drench it, but pull the cheek away from the teeth so as to form a pouch, into which the medicine may be slowly poured. It will flow from the cheek into the mouth, and when the hog finds out what it is, it will stop squealing and swallow. In our experiments hogs which were so sick that they would eat nothing have commenced to eat very soon after getting a dose of the remedy, and have steadily improved until they appeared perfectly well.

This medicine may also be used as a preventive of these diseases, and for this purpose should be put in the feed of the whole herd. Care should of course be observed to see that each animal receives its proper share. In cases where it has been given a fair trial, it has apparently cured most of the animals which were sick and has stopped the progress of the disease in the herds. It also appears to be an excellent appetizer and stimulant of the processes of digestion and assimilation, and when given to unthrifty hogs it increases the appetite, causes them to take on flesh, and assume a thrifty appearance.

This is a résumé of the reports from the tests of this medicine during the last year, and while I should prefer, from a scientific point of view, to continue these experiments for another year before venturing to recommend it as a remedy for these diseases, the many urgent requests which have been made upon me for the formula lead me to give it in time for it to be tried by our farmers during the current year. Those who are interested in this subject are earnestly requested to try this

mixture and report their results to this Bureau for the benefit of the hog-raising industry.

Success or failure with this remedy depends largely upon the manner in which it is used. If it is improperly administered, or the hogs left out in cold storms and compelled to remain day and night in mud six inches or a foot deep, under the necessity of searching through this mud to find an ear of corn in order to get anything to eat, the farmer might as well save his money and let his hogs die, as nothing which we have been able to find will save them under such conditions. If, on the other hand, the sick animals can be made reasonably comfortable, and given soft, easily digested food to eat, the medicine, of which we have just given the formula, may be used with confidence that it will give good returns for its cost and the trouble of its administration.

In treating hogs for these diseases it must not be forgotten that in nearly all cases there is more or less inflammation of the internal organs, and particularly of the stomach and intestines. To treat such diseases successfully the animals should be kept dry and comfortable, and where drafts of air will not blow upon them. The food must be such as can be digested by the irritated and inflamed organs which are charged with this function. With these general principles in mind the farmer may undertake to treat his sick hogs with a fair prospect of success. He may not save them all, but he should be able to preserve a good proportion of them.

The question now arises, What disposition should be made of the hogs during treatment, and what sanitary measures should be adopted in addition to the medical treatment? When the hogs are first found to be affected with hog cholera or swine plague the lot or pens where they have been confined should be disinfected by dusting plentifully with dry, air-slaked lime, or by sprinkling with a 5 per cent solution of crude carbolic acid. The animals should then all be moved to new quarters. If possible, the sick and apparently well should be separated before they are moved and then put into different lots. This is not essential, but it is an aid to the treatment. The hogs should be kept in dry lots, or pens, where there is no mud, and, *above all*, no stagnant water. It is well to keep these lots disinfected by the free use of air-slaked lime or carbolic acid.

It is not expected by this supplementary treatment that the hogs will be entirely removed from the influence and attacks of germs. This is not necessary. The number of germs which gain access to their bodies may be so reduced by following this plan, however, that the vital force of the system, assisted by the medicine, is sufficient to overcome them.

During this treatment the hogs gain a marked degree of immunity. No doubt this is the result of attacks of the disease from which they recover. This recovery is in spite of the continued infection of the

premises, and even though the hogs which have gone through the outbreak are apparently well and thriving, new hogs added to the herd are liable to be attacked. For this reason five or six months should be allowed to pass before any new hogs are purchased and brought on the premises or before any are sold to be put among other lots of hogs. Young pigs born under such conditions in some cases are able to resist the infection, while in other cases they may suffer severely or die.

If any hogs die during the progress of the outbreak their carcasses should be immediately burned or deeply buried, and the places where they have lain or the ground over which they are dragged should be disinfected with carbolic acid or lime according to the method already mentioned.

SANITARY MEASURES TO PREVENT THE INTRODUCTION OF HOG CHOLERA AND SWINE PLAGUE.

The swine-grower should use every effort to prevent the introduction of the contagion of these diseases upon his premises. If he purchases hogs from a distance or sends his own animals for exhibition at the fairs, he should insist upon their being transported in clean cars, which have been disinfected if they have previously carried swine. When new hogs are brought upon the farm or when his own return from exhibition, they should be rigidly quarantined and not allowed to come in contact with the other hogs on the farm for at least six weeks.

Hogs should not be allowed to run at large in the vicinity of railroads over which swine are transported. Infected hogs are frequently shipped to market, and there are sufficient droppings from the cars in which they are carried to scatter the contagion along the railroad for the whole distance they travel.

When these diseases appear upon a neighboring farm precautions should be adopted to prevent the introduction of the contagion. No one should go upon the fields or into the pens where the sick animals are and then go to another farm where the disease has not appeared. Remember that a particle of manure or dirt the size of a mustard seed from an infected farm is sufficient to start an outbreak that will destroy a herd of swine. A particle of that size may be carried upon the shoes of a visitor, upon the foot of a dog or other animal, upon a wagon wheel, or in a multitude of other ways. Nonintercourse at such a time is therefore the safest rule.

Experience shows that hogs kept up in a pen or small lot are less subject to infection when cholera is in the neighborhood than those which are allowed to run at large or in the fields. It is, consequently, advisable, when there is reason to fear this disease, to keep the hogs in a small inclosure, which should be as dry as possible, and disinfected once a week with air-slacked lime or a 5 per cent solution

of carbolic acid. A small quantity of carbolic acid (3 to 15 drops, according to age) in the drinking water tends to prevent infection and may have a beneficial influence upon the course of the disease.

PREVENTION OF DISEASE BY PROPER BREEDING AND FEEDING.

There is occasionally a herd of swine that does not contract hog cholera even though exposed to the contagion. Two herds may sometimes run together and be exposed to the same extent; one will be nearly or quite destroyed, while the other does not suffer. These facts naturally lead to the inquiry as to whether it is possible to so breed and feed hogs as to largely or entirely prevent the most common diseases. To what extent disease may be prevented in this way, we are not in a position to state, as we are not familiar with enough experiments to enable us to reach a conclusion. It is clear, however, that something can be accomplished in this way, and as the carrying out of the plan would also increase the hardiness and thriftiness of the swine it is certainly worthy of adoption.

The first principle of this method of prevention is to breed only from mature breeding stock which is only distantly or not at all related. The second principle is to select, if possible, animals for breeding stock which have shown, by having passed through an outbreak without becoming affected, that they possess a power of resisting hog cholera. The third principle is to feed the growing shoats upon a variety of food which will lead to normal and harmonious development of all the different organs. The application of these principles must be made by the individual breeder in accordance with his circumstances and surrounding conditions. The breeding from mature animals which are not closely related can be easily adopted by anyone. The selection of stock which has shown that it possesses a power of resisting the disease is much more difficult, and in many cases it will be impossible for the general farmer, though there are many breeders who could experiment in this direction.

The diet of corn alone, upon which the hogs of so large a part of the country are raised, has done more than anything else to weaken the vital powers of these animals. With wheat selling in the markets of the country as low as corn, there is no longer any excuse for limiting the food of hogs to a single grain. Wheat is much better than corn for growing animals, but should be crushed or rolled to give the best results. Ground oats, middlings, bran, and pease may also be used to give variety. It is hardly necessary to add that during the warm months of the year hogs should have plenty of young grass or clover.

By intelligently applying these principles in the production of the breeding stock a strain of animals may be developed which is hardy, vigorous, prolific, and much more capable of resisting disease than is the ordinary inbred and corn-fed stock which is now so generally used by the farmers of this country.

This bulletin is prepared for the practical use of the farmer; it is intended to be suggestive rather than exhaustive; it contains the important points necessary for identifying and controlling the infectious diseases of swine. If its teachings are intelligently and thoroughly followed the losses from these diseases may be greatly reduced. Experience having demonstrated that such beneficial results are possible, it has been deemed best to present this information in a condensed and popular form.

FARMERS' BULLETINS.

Applications for bulletins of this series should be addressed to the Secretary of Agriculture, Washington, D. C.

Farmers' Bulletin No. 1. The What and Why of Agricultural Experiment Stations. Pp. 16. Issued June, 1889.

Farmers' Bulletin No. 2. The Work of the Agricultural Experiment Stations. Pp. 16. Issued June, 1889.

Farmers' Bulletin No. 3. The Culture of the Sugar Beet. Pp. 24. Issued March, 1891.

Farmers' Bulletin No. 4. Fungous Diseases of the Grape and their Treatment. Pp. 12. Issued March, 1891.

Farmers' Bulletin No. 5. Treatment of Smuts of Oats and Wheat. Pp. 8. Issued February, 1892.

Farmers' Bulletin No. 6. Tobacco: Instructions for its Cultivation and Curing. Pp. 8. Issued February, 1892.

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Farmers' Bulletin No. 8. Results of Experiments with Inoculation for the Prevention of Hog Cholera. Pp. 40. Issued May, 1892.

Farmers' Bulletin No. 9. Milk Fermentations and their Relations to Dairying. Pp. 24. Issued July, 1892.

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Farmers' Bulletin No. 20. Washed Soils: How to Prevent and Reclaim Them. (In press.)

Farmers' Bulletin No. 21. Barnyard Manure. Issued Nov. 19, 1894.

Farmers' Bulletin No. 22. Feeding of Cattle. (In press.)

Farmers' Bulletin No. 23. Foods: Nutritive Value and Cost. (In press.)

...The Swine Industry in Indiana...

BY A. W. BITTING, PURDUE UNIVERSITY.

The capital invested in the swine industry in this state is so large that it can not be comprehended. It may be stated in figures and compared with the capital represented by other products of the farm and of large manufacturing industries. Only three products of the farm, corn, wheat and horses and the product of only one industry, the packing industry, have a greater value. The value of the hogs raised upon the farms in this state each year is equal to two times the value of all the buggies and wagons, two and a half times that of all the glass, three and a half times that of all the furniture or four times that of all the farm machinery manufactured during the same period. The loss to the industry for the year ending May 31, 1897, was equivalent to two times the value of all the coal mined or three times the value of all the stone quarried for the same time. The entire loss of wages due to the coal miners' strike in this state one year ago, a strike of unusual duration, causing destitution and suffering in a large number of homes and a general appeal for public alms, was probably not as great as the loss sustained by the farmers in a few counties. It is only when we get all the facts together that we can form some conception of how large the swine industry really is.

According to the latest reports Indiana ranks eighth in the production of hogs. Iowa, Ohio, Missouri, Illinois, Texas, Kansas and Nebraska excel her in the order named. Pennsylvania has practically the same number.

It is difficult to obtain statistics upon the swine industry by which comparisons can be made from year to year as the methods used in collecting the statistics have not always been the same. Without giving the details, the average number of hogs produced from 1883 to 1890 inclusive was 4,243,825, and the loss 338,359 head annually. From 1891 to 1894 no record was kept. The production and losses for 1895, 1896 and 1897 are as follows:

	No. produced.	No. died.
1895	2,890,797	278,143
1896	3,258,580	580,267
1897	3,638,535	899,457

As these figures were obtained from the assessors' reports they are approximately correct. They indicate that we are producing fewer pigs now than prior to 1890. The great loss in numbers for 1895 can be attributed to the drought

of 1894 making a shortage of corn There is an increase in the total number produced for 1896 and 1897, but the number marketed was far below normal owing to the great losses from cholera. The figures for the year ending May 31, 1898, will soon be ready and it is probable that they will show an increase in production and a marked diminution in loss.

The importance of the hog as a factor in the production of wealth becomes conspicuous when placed in a classified list of our most important products.

Corn (approximate value)	$40,000,000
Wheat (approximate value)	35,000,000
Packing products	30,000,000
Horses and mules	25,000,000
Hogs	**21,800.000**
Cows	18,000,000
Iron manufactured products	17 800,000
Beef cattle	17,000,000
Oats	11,500,000
Oil	10,500,000
Wagons and buggies	9,277,000
Glass	8,740,000
Furniture	6,600,000
Farm machinery	5,740,000
Sheep	3,500,000
Coal	2,737,000
Stone	1,960,000

As a rule we form our estimate of the importance of a business by the number of men engaged in it. When these are brought together in large manufacturing establishments it does form an impressive object lesson. The importance of some of our manufacturing enterprises thus often become magnified out of all proportion to other industries. The hog is owned by more individuals than any other domestic animal. Nearly every farm supports a greater or less number and many are rai-ed in lots in the rural towns. The greater number are raised in herds of from thirty to fifty, herds of two hundred are not common and herds of five hundred to one thousand are rare.

Whatever epithet may be applied to the hog or the business of raising hogs, he is unquestionably one of our greatest sources of wealth. Whether the price received be high or low he still helps to keep the balance upon the proper side of the ledger. There can be no more certain evidence of this than the fact that with a very high loss from disease farmers are not dissuaded but continue to raise them. He has been justly called the "mortgage lifter" and without doubt more Indiana farms have been cleared of incumbrance through his assistance than in any other way.

The raising of hogs is attended by greater losses from disease than befalls other classes of livestock. The disease of hogs spreads over whole sections as an epidemic, destroying from ten to ninety percent of all herds attacked. This constitutes the uncertain factor in their management. These diseases can not be wholly avoided even by the best management. They can be controlled to a certain extent. The profits in this industry, like every other, depend upon the individual managing it. The hog may be depended upon to do his part if given the opportunity.

...Hog Cholera and Swine Plague...

BY A. W. BITTING, PURDUE UNIVERSITY.

There is probably no subject of interest to agriculturalists and stockmen that has occupied more space in the press in this country in the last fifteen years than the one that heads this article. It seems as though it has been worn threadbare and to some it has become trite. As long as these two diseases remain the greatest plague to the live stock interests of this country, causing more loss than all other diseases combine a discussion of their character and prevention can not become trite. One year ago Indiana alone lost more than $5,000,000 due to these diseases. Last year we escaped with comparatively small loss and now the number of outbreaks reported indicates that we shall not fare so well this season.

Some very important researches were made upon these diseases last year and it seems a very opportune time to review the whole subject and present the latest information that has been brought out by the experiments in different places. In the following series of articles I shall go into greater detail in the discussion of the subject than is usual in newspaper articles in order to explain many of the points that are not generally understood.

HISTORY.

Hog cholera is not such a new disease as many are wont to tell us. It is frequently asserted by old men that twenty or twenty-five years ago hog cholera and swine plague were unknown. It seems probable that the disease was not so generally distributed or as common in the early settlement of the state, but there seems to be very well authenticated reports of outbreaks fifty to sixty years ago. We will probably never know when the first case of hog cholera occurred, but according to the Bureau of Animal Industry there was an outbreak of this disease in Ohio in 1833, sixty-five years ago. An outbreak was reported to have occurred in South Carolina in 1837, one in Georgia in 1838, and in Alabama, Florida, Illinois and Indiana in 1840. As close observations and records were not made upon stock diseases at that time many outbreaks escaped unreported.

According to the early reports, hog cholera was introduced into this state from Ohio by the driving of hogs to the southeastern and southern counties for the purpose of fattening. At first the disease was confined to a strip along the Ohio river, but it gradually spread north-

ward and westward until it reached Terre Haute in about 1847 or '48. In the first state agricultural report published in 1859-60 the leading article is upon hog cholera, and it records heavy losses to the industry in the southern part of the state. It is interesting to note in this connection that the description given then and the remedies are not very different from the better articles offered to-day.

The disease which we call hog cholera is recognized as being identical with the disease called swine fever in England. According to some writers the disease was imported with hogs brought to this country from England for the purpose of improving our breeding stock. Whether this was or was not the case matter slittle to us now from a practical standpoint, as it is now distributed over the entire country and is thoroughly established.

Swine plague was not recognized until several years after hog cholera had been described. Swine plague seems to be like the German hog disease, *schweinseuche.*

LOSSES.

The total loss caused by the swine diseases has been estimated at from $10,000,000 to $25,000,000 annually in the United States. During the unusual scourge in 1896 it is probable that the loss reached $45,000,000. The annual loss in this state aggregates more than the entire income from some of the more important industries. According to the Bureau of Statistics the losses in the different years have been as follows:

	Number.
1883	288,286
1884	351,156
1885	326,555
1886	402,164
1887	512,692
1888	326,359
1889	247,114
1890	256,991
1895	278,143
1896	580,267
1897	899,457

The average loss is 406,290 hogs having a value of more than $2,000,000 for each year of which we have record. The most discouraging thing to report is that there is little prospects of an abatement of this loss. The risks in contracting the disease are no greater than at any time during the past ten years. The means of prevention are better understood so that in fact it is smaller. The losses will continue because of the carelessness of thousands of breeders. The unfortunate feature is the fact that they are not the only losers but they inflict untold injury upon their more careful neighbor.

TWO DISEASES.

The diseases of swine have been very carefully investigated by the United States Bureau of Animal Industry, and the greater part of what we know concerning them comes through this source. Credit is also due to many individuals for what they have contributed, but it is to our Bureau that the greater honor belongs. They have decided that there are two wide-spread diseases that cause the heavy losses among swine, hog cholera and swine plague. Outbreaks occur in which it is easy to distinguish which is present and again there are outbreaks where both diseases may be present in the same herd or even in the same individual and it becomes difficult and often impossible to distinguish between them.

There is a specific germ for each of these diseases. Hog cholera is caused by the germ or bacillus of hog cholera and swine plague is caused by the bacillus of swine plague. These germs differ in size, shape, activity, method of growth, resistence to external conditions and their effects upon the body. These differences are recognized by those working with the disease but of course can not be seen without the special

equipment found in laboratories. Briefly stated the differences between the germs are as follows:

The hog cholera bacillus is a small plant about 1-25000 to 1-15000 of an inch long.

The swine plague germ is only about one-half the size.

The hog cholera germ is shaped like a short cylinder, slightly rounded at both ends and a number of delicate projections like hairs extend from it at different places.

The swine plague germ is oval and perfectly smooth.

The hog cholera bacillus has distinct movement.

The swine plague germ has no movement.

The hog cholera bacillus will stain uniformly.

The swine plague bacillus will stain only at the ends.

Hog cholera bacilli will live in water from two to four months.

The swine plague bacilli will live only from ten to fifteen days.

Hog cholera germs will live in soil from two to three months.

Swine plague germs will live from four to six days

When hogs are fed upon cholera germs they will contract the disease.

When they are fed upon swine plague germs they do not become diseased.

Inoculation with hog cholera germs produces disease of the intestines.

Inoculation with swine plague germs produces disease in the lungs.

There are other characteristic differences between hog cholera and swine plague germs but a detailed statement of them would hardly be understood by the general reader. The differences pointed out above should be sufficient to convince the skeptical that there are two distinct germs. Their effect upon the body and the symptoms will be described later.

The specific cause of hog cholera is the bacillus of hog cholera and the cause of swine plague is the bacillus of swine plague. No other cause can produce either of these diseases. Other causes may cause diseases with similar symptoms which may be mistaken for them, and other causes may so weaken the body as to make the animal especially susceptible to these diseases, or external conditions may be such as to act favorably in the distribution of the germs. These causes then are secondary but are very important.

THE EFFECT OF THE GERM UPON THE BODY AND THE POST-MORTEM APPEARANCE.

The germs of hog cholera are found in the blood and in the internal organs They have the habit of growing in bunches, and as they are carried along the blood stream to the very small arteries and capillaries they form little plugs and arrest the circulation in the part. This accounts for the red blotches that are seen in the fat and meat of a hog that dies with the cholera. These blotches are so characteristic that meat inspectors at the large packing establishments have no difficulty in recognizing a cholera hog when hanging upon the gambrel stick. Another characteristic of these blotches is that they become redder in time after death. Red spots from other causes gradually disappear. These red spots are especially prominent under the skin, under the membrane lining the abdominal cavity and between the coats of the intestines. This plugging of the arteries causes death of the tissue for want of circulation, and it seems probable that much of the cracking and sloughing of patches of skin is due to this cause.

The spleen, or melt as it is frequently

called, becomes enlarged, soft and filled with blood. In the cases which continue several days changes take place within the intestines. Ulcers from the size of a pin-head to that of a grain of corn will form on the inside of the large intestine. They project slightly above the level of the wall and have a yellowish, reddish or dark brown appearance. Sometimes these completely perforate the intestine. In the acute cases the bloody patches are the characteristic lesions, while in the less acute or chronic form the intestinal ulcer is the prominent lesion. The lungs as a rule are not affected and collapse at death.

In swine plague the germs do not collect together in bunches but are evenly distributed. The reddish patches throughout the body are not seen. The lungs are congested and if the hog dies of acute disease they are generally engorged with blood and the air tubes are filled with frothy mucus, and hence they do not collapse. If the disease is somewhat prolonged the lungs show numerous small spots containing pus. Very often there is pleurisy and the lungs become attached to the ribs. The intestines may become involved and there will be considerable thickening of the walls.

It will therefore be seen that hog cholera peculiarly affects the intestines and that the disease may extend to the lungs, while swine plague affects the lungs and in chronic cases involves the intestines. When both diseases are present the lesions of both may be recognized.

In this connection it might be well to add that it is a good policy for all farmers to hold post-mortem examinations upon their stock when they die, as they will soon become familiar with the appearance of different organs in disease. It will make them more observant of symptoms and to recognize the symptoms characteristic of diseases in the different parts of the body. A post-mortem may often be the means of diagnosing between a contagious and non-contagious disease, and thereby be of material assistance in deciding the proper course to pursue with the stock that remain.

THE LIFE OF THE GERMS OUTSIDE OF THE BODY.

The general behavior of the germs inside of the body, the period of incubation or the time required for them to multiply in sufficient numbers to cause evidence of disease and the general lesions produced are pretty well understood, but the history of the germ outside of the body is not so well known. This is one of the important points that remains to be determined.

The experiments which have been made with the hog cholera germ have not shown it to be able to live more than a few months in water or soil and that the swine plague germ lives less than half as long as the hog cholera germ. The results of these experiments are at variance with the experience that comes to any one who has had much experience in the field. It is not an uncommon occurrence to have an outbreak of hog cholera follow the turning of hogs upon a field where the disease had been and the dead buried twelve or eighteen months before, as a result of the new hogs rooting out the bones and remnants of the carcasses of the dead. I have seen a typical outbreak of cholera occur as a result of turning hogs into an old house that had been used as a pen three years prior. The first set of hogs had sickened and died there during an epidemic, the doorways had been filled with rails and no stock of any kind had access to it until the next set of hogs were given the quarters as a shelter. The straw or bedding had

not been removed and no changes of any kind were made. The outbreak that followed the introduction of the second bunch of hogs occurred in about ten days or two weeks after their admission to the house and was the only herd in the country that was affected. People have related many cases to me similar to the above, the period sometimes being longer and at other times shorter. Again we have noted the occasional turning of fresh hogs into pens from which dead hogs had just been removed and no disease followed. We can not explain all these apparently inconsistent conditions upon the evidence from our experimental data.

In some diseases, as glanders, the germ which produces it can live for only a short time outside of the body and hence can only be conveyed by close contact of the animals or the placing of animals in stalls previously occupied by others that were affected. Such diseases can be stamped out by slaughter and rigid quarantine. Hog cholera and swine plague do not belong to that class of diseases. In another class of diseases, of which anthrax is a good example, the germs can live in the soil for years and be able to produce the disease when a favorable opportunity arises. Anthrax has been observed to result from the eating of green forage that grew over the grave of an animal that died of the disease. There are observations recorded which show that the germs must have lived in the ground for seventeen years and produced the disease.

The experiments with hog cholera germs have not shown them to have the resistive qualities attributed to anthrax germs. There are many who do believe they possess similar life properties. If they do, then the problem of prevention becomes still more difficult to handle.

Our present knowledge of the germ tends to show that in many respects its life history is somewhat like that of the germ of typhoid fever. No one would claim that they are identical or that typhoid was as virulent or contagious as hog cholera, but there are points of resemblance. The lesions and character of the diseases are so much alike that cholera has often been called pig typhoid. When a drop of blood is drawn from a typhoid patient and placed in a drop of culture containing typhoid germs it causes a stoppage of all movement and a clumping together. When a drop of blood from a cholera patient is put into a culture containing cholera germs it produces a similar result. Typhoid fever germs are never found outside of the body of a sick patient, but it is well established that they are taken into the system through the water supply. Epidemics of typhoid fever occur in cities and no matter what be the source of the water supply, river, lake or well, it will be found that the water is polluted by the discharges of people. Typhoid fever can always be arrested by securing a pure water supply. The researches of this station have shown that hog cholera is also a water borne disease, and that in a series of epidemics in this state from 33 to 200 per cent more disease has occurred from the general use of surface water than from the use of well water. There is need for much more research upon the life history of the germ outside of the body before we can be fully prepared to say what can and what can not be done toward controlling the disease.

Less is known about the life history of the swine plague bacillus than the hog cholera germ. Germs, very much like the swine plague bacillus, have been found in the air passages of calves and other animals. If upon further investigation it should be found that the swine plague bacillus may also cause pneumonia in other animals the prob-

lem of control becomes correspondingly increased.

THE WAYS THROUGH WHICH THE GERMS ENTER THE BODY AND CAUSE DISEASE.

Experiments have been conducted to determine the ways through which the germs enter the body and cause disease. Hogs fed upon the carcass of an animal affected with hog cholera develop a virulent form of the disease in a short time. In this case the intestines become the seat of typical lesions while in other parts of the body the lesions are less prominent. Hogs given the germs of hog cholera in food or water develop lesions of the same character. These results show that when the germs are introduced into the intestine with either food or drink the disease is likely to develop.

Experiments were also conducted to determine the effect of taking the germs into the lungs. Germs were sprayed in the air so that the hog would of necessity inhale them but the disease did not result. Germs were introduced into the windpipe so that they would be carried into the lungs. No disease of the lungs followed the treatment and cholera did not result. The conclusion is that the disease does not occur in ordinary cases as a result of inhalation.

Germs were also inoculated beneath the skin, but in only a few cases did death result. It is only when a very large number of germs were introduced or of a very virulent character that disease resulted. This would indicate that the hogs do not contract the disease by natural inoculation as the bite of lice, breaking of the skin, etc., and the introduction of the germs.

Inoculation of the germs into the veins was more successful than under the skin, but the number required for successful infection is altogether too large to consider it a means of infection occurring in nature.

The results of all the work along this line have been to show that the infection of hog cholera is most easily introduced through the intestinal tract and that in nature the infection probably occurs with the food and water.

A similar line of experiments have been conducted with swine plague. The germs of disease may be taken into the stomach by eating a carcass from a hog dead with the disease or by placing the germs in the food and infection not take place. When the hog is made to breathe air in which the germs are sprayed or when the germs are injected into the windpipe the disease will occur. In this respect it differs from hog cholera.

The inoculation experiments both under the skin and in the veins indicate that it is probably not an ordinary method by which infection can take place in nature.

The conclusion from these studies is that swine plague is induced under natural conditions by inhaling the air containing the germs.

ACCESSORY CAUSES.

While hog cholera and swine plague are each contagious and infectious diseases produced by specific micro-organisms, we must also recognize all accessory causes. By accessory causes we mean all those influences which in any way contribute to the distrobution of the germs or aid in their multiplication, and also anything which will weaken the vitality of the animal.

Among the agencies which may carry the germs are streams, winds, birds of carrion, dogs, people passing from one herd to another, wagons, driving diseased hogs over public highways, buying hogs from infected herds, shipping hogs in unclean cars, exhibiting at fairs,

etc. Some of these means are not within our control, but many are and a proper understanding of them should lead us to prevention in thousands of cases where it occurs now.

Undoubtedly the most important agency in the distribution of the disease are the streams and surface water supplies. I have emphasized this point often but it will bear repetition. It has been known for some time that there was a relationship between the water supply and the disease, but it is only since the investigations by this station were undertaken that the real facts have been ascertained. In 1895 the 60 townships bordering upon the Wabash, from Cass county to its mouth, show a loss of 150 head out of every 1,000 produced; 47 townships in the second tier removed from the river show a loss of 100 head per 1,000, or 50 per cent more loss in the first tier than in the second tier. In 1896 the bordering townships lost 294 hogs per 1,000, the second tier 205, and the third tier 160. In other words, the loss was 43.4 per cent more in the first tier than in the second tier, and 83 8 per cent more than in the third tier.

In 1895, 44 townships bordering upon the north fork of the White river lost 138 hogs per 1,000 and 42 townships in the second tier 65 hogs per 1,000, or 112 per cent greater loss in the townships bordering upon the river than in those a few miles removed. In 1896 the loss in the first tier was 231 per 1,000, in the second tier 156, and in the third tier 75, or 48 per cent greater loss in the first than in the second and 208 per cent greater than in the third. In 1896, 44 townships bordering upon the south fork of the White river lost 200 hogs per 1,000; 58 townships in the second tier lost 150, and 42 townships in the third tier lost 10J; thus making 33 per cent more loss in the first than in the second, and 83 per cent more loss than in the third. In 1897 the first tier of townships bordering upon the river lost 321 hogs per 1,000, the second tier 182, and the third tier 145; 76 per cent greater loss in the first than in the second, and 121 per cent more than in the third.

In every general epidemic of the disease of which I have record in this state the disease has spread from the rivers to the higher land. The evidence furnished by the large number of townships and for successive years should leave no doubt as to the important role which streams and surface water play in the spreading of this disease. If the larger streams are such important factors we can reason that the smaller streams have a like effect. Drs. Salmon and Smith made the following statement in their investigations of the disease. It is pertinent and should be remembered by all swine breeders: "Perhaps the most potent agents in the distribution of hog cholera are streams. They may become infected with the specific germ when sick animals are permitted to go into them, or when dead animals or any part of them are thrown into the water. They may even multiply when the water is contaminated with fecal discharges or other organic matter. Experiments in the laboratory have demonstrated that the hog cholera bacilli may remain alive in water four months. Making all due allowance for external influences and competition with the bacteria in natural water, we are forced to assume that they may live at least a month in streams. This would be long enough to infect every herd along its course."

It is a common practice throughout this state to give the hogs surface water in which to wallow and to drink. Small streams are dammed, drinking places are built into the rivers, a basin is scooped out to receive the water from a barnyard, open ditch, tile drain or spring.

All of these afford the best conditions for introducing the germs into the herd. It is not uncommon to go along a public ditch or a stream during an epidemic and find the carcasses of hogs in every stage of decomposition thus acting as the bearer of infection to new herds. The conditions are better now than ever before, but there are unscrupulous men who will take that means of disposing of their dead and some one else must suffer.

Some springs afford pure water but many have only a surface origin and are no better than a tile drain. The worst feature connected with the use of a spring as a water supply is the fact that no provision is made for keeping the water clean and pure. The water usually collects in a pool and receives the surface drainage from all the land around and serves as a wallow. Under such circumstances it becomes little better than a pond.

In 1895 the station made an inquiry as to the source of the water supply used by the breeders of pure-bred swine. It was found that in nearly all instances in which they escaped disease they used well water. Hogs receiving well water do become affected, but when we consider the numerous ways by which the infection can be carried we are not at all surprised. A good well, however, must always be considered as furnishing the maximum protection.

A study was also made of the relation of rainfall to the disease. No relationship could be traced to the total rainfall for the year or to the total rainfall for any set of months. In general, a season with sufficient rainfall to keep a constant supply of fresh water in the streams or one of sufficient drought so that the small streams, ponds, etc., become completely dry, are productive of least cholera. A year in which there is much stagnant water is productive of the greatest death rate.

The argument is advanced that the greater loss occurs along the rivers because more corn is raised, more hogs are fattened, and hence they are more crowded. In order to determine this point we divided the counties in the state into groups according to the number of hogs raised per square mile and determined the per cent of loss for these groups. This is presented in the following tables:

1883-1890.

Number of hogs per square mile.	Number of counties.	Per cent of loss.
1- 24	1	8.1
25- 49	7	4.5
50- 74	20	5.9
75- 99	12	9.1
100-124	16	8.3
125-149	11	7.9
150-174	7	8.1
175-199	10	8.8
200-224	8	10.

1895-1897.

1- 24	2	7.7
25- 49	22	9.1
50- 74	18	11.1
75- 99	16	17.9
100-124	12	19.2
125-149	8	17.3
150-174	7	21.6
175-199	4	22.2
200-224	3	26.

During a period of eight years there is comparatively little difference in the losses, but during the period of three years when the disease raged with unusual violence the percentage was much higher in the counties having a large number of hogs per square mile. It is not possible to tell how much of this increase in loss is due to the greater number of hogs, as it so happens that the counties having a very large number of hogs per square mile and large percentage of loss also have one or more rivers passing through them. From a comparison of counties about equally situated but the number of hogs per square mile very different, I am of the opinion that the number raised is

not a very important factor in determining the per cent of loss.

The season of the year when cholera is most prevalent is always in the late summer and fall. It occurs at all times of the year, but like all the intestinal diseases, as dysentery, typhoid fever, etc., in people, the conditions are more favorable for germ development in the fall.

The germs of the disease may be carried from one place to another by birds of carrion. It is a common experience with farmers that hogs can not be raised upon a farm where there is a buzzard roost. I have learned of isolated outbreaks of the disease occurring from buzzards alighting to eat from the carcass of a colt or other animal and after the hogs gain access to the same place soon after.

Dogs prowling about at night carry pieces of dead animals for a mile or more, across pasture fields, feed lots, leaving pieces here and there to be devoured by some unfortunate animal.

Men may carry the disease from place to place upon their boots, or particles of dirt remain upon the wagon wheel and when dry drop off in another lot. It should be a general rule never to allow agents for hog cholera cures to come near a pig lot where there are healthy hogs. They go about diseased hogs and do not use the precautions necessary to prevent the spread of infection.

Under some circumstances I believe the wind may be the bearer of germs. If the germs be distributed along a public highway by the rendering wagon become mixed with the dust it is possible and altogether probable that they may be blown on the pasture or on the feed lot and thus convey disease. I have seen a few outbreaks continue in one direction for several days after a constant prevailing wind from the southwest. The evidence in this case seemed to point to the wind as the distributing agent. In such cases the germs fall in the water or are taken in with the food.

Hog cholera is often contracted as a result of buying hogs from stockyards for feeding purposes. This is such a common experience that only the strong headed or uninitiated will be likely to take the risk. The large stockyards and the majority of shipping cars are permanently infected with disease and no matter how healthy the hogs may have been when they started from home, they come in contact with infection and should never be withdrawn from the yards for feeding purposes. We have recorded many outbreaks caused in this way. It has been claimed that the shipping of diseased hogs over the railroad may be the means of causing new outbreaks of disease. I made this a particular object of research in 1895 and 1896, but in no case have I been able to find more cholera along railroad lines than at a distance of a mile or two upon either side. Under the present method of having the right of way fenced I feel certain that the infection from this source is over rated.

It would be useless to try to go into detail concerning all the methods by which the disease is distributed. Any means by which the germs are carried from one place to another can be considered an anccessory cause. All of these means are not under our control but many are and we will succeed in prevention in the same measure as we eliminate them.

The second class of accessory causes are those which diminish the resistive power of the animal. These are not as important as those of the first class. These are usually considered under feeding, shelter and breeding.

The disease has often been attributed to the feeding of green corn, too much

corn, etc. In 1896 the Iowa weather bureau published a map showing the distribution of the disease in the state. It was found that the disease caused greatest loss in those counties in which corn formed almost an exclusive diet. In the counties in which dairying was the prominent feature the disease caused least loss. The conclusion was at once drawn that the feeding of so much corn was the cause. In 1897 the conditions were reversed. the disease being most serious in the dairy districts. This disproved the conclusion of the previous year. It may be said that the feed is about the same every year but that the disease does not follow which would be the case if dependent upon feed. The feeding of green corn or all corn can not be considered a wise practice as a health measure. If green corn be fed it should be given much the same as to cattle, a little at first with some old corn and gradually increase the quantity as the animal is able to stand it. The feeding of green corn is likely to produce a diarrhoeal and feverish condition that will make the animal more susceptible. An injudicious management of any kind of feeding will have the same effect. The hog needs a variety for strength and health and those best prepared to furnish will probably fare best.

The hog needs some shelter; it need not be elaborate, something to break the scorching sun or beating storm, and have dry quarters in which to sleep, but not much bedding, and a clean floor from which to eat. The straw stack is the poorest shelter he can be given as he buries himself under the straw; a shed with sides to break the wind and a dry floor on which to lie is the best. A tight wooden platform on which to throw the feed is an adjunct that should never be overlooked.

Whether a hog is pure-bred or cross-bred makes no difference to the disease germ. An objection often made by farmers against pure-bred swine that they are less resistive to disease is not well founded. The razor-back, with digestive powers capable of utilizing anything that may be called food and possessed of the vigor and strength equal to any animal, will succumb to the disease the same as the finely bred Berkshire or Poland China. No breed of hogs is immume to the disease, so that we can not obtain immunity by any manner of cross that we know anything about. Above all we should not make the mistake of introducing the coarse blood of the razor-back or piney woods for the purpose of obtaining vigor and immunity against the disease. All the vigor that will avail against the disease may be obtained by using care in the handling of the improved breeds.

SYMPTOMS.

The diagnosis of the different diseases of swine is attended with greater difficulty than the diagnosing of diseases in horses or cattle. Except upon very careful examination the general symptoms of all swine diseases appear much alike, and as cholera assumes several forms it becomes evident that the recognition of the disease can not be made upon any specific set of symptoms.

The symptoms of hog cholera vary greatly with the virulence of the outbreak. It may be said to assume an acute form in which the disease lasts only a few hours to a couple of days, a sub-acute form in which it runs its course in from two days to a week or more, and a chronic form in which the disease lasts from ten days to a month. The symptoms vary in intensity in each of these forms. The symptoms as here described will be for the sub-acute form. About the first symptom noticed is that the hog is droopy, that his eyes are more or less closed and not clear, that

the ears drop more than usual, that there is sluggishness, and although the hog eats, it is not with that greediness that we are accustomed to see. The hog lies about more than usual, hiding in fence corners, under litter and in out of the way places. If they have access to a manure pile that will be found to be a favorite place. During the hottest days they will lie out in the sun when they would ordinarily remain in the shade. They are not very responsive to calling, and will get up only when urged to do so. During the progress of the disease, and often at the very beginning, there is a rheumatic form of lameness. The hog will be lame first in one quarter then in a short time it will move to another. The back aches, and sometimes there is paralysis of the hind quarters. A diarrhoea develops sooner or later, the faeces having a dark color and a very offensive odor. Sometimes the hog will have an abnormal appetite and will eat dirt, especially clay, which becomes impacted in the intestines, forming a hard cast. In such cases constipation is marked. Vomiting is also a symptom. The ears and tail swell and crack, sometimes dropping off. Ulcers may form on the skin from the size of a dime to that of a dollar. The eyelids gum together. A redness of the skin occurs on the legs, belly and sides, becoming more marked as the animal becomes worse. In hog cholera there is little or no coughing at first, but this develops later. The coughing is paroxysmal, occurring when the hog first gets up and after exercise. The characteristic symptoms are those of bowel trouble.

In the acute form the poison of the disease causes sudden collapse, and the train of symptoms are not developed. It is frequently observed that the hog will eat a meal at the usual time and be found dead a little later. In the chronic form the symptoms are prolonged and of less severe type. If the hog recovers he loses his hair, and rarely is worth anything. In hog cholera the great fatality occurs to pigs and young hogs. A considerable per cent of old hogs do not become affected or make recovery.

In swine plague the symptoms are more characteristic of lung trouble. The cough is developed early; it is first paroxysmal, a half dozen to a dozen hacks and then a cessation. This is more noticeable when the animal first comes from his rest or after exercise. Later the cough is more persistent. When the animal breathes there is little movement of the ribs, and a double hitch in the flank, as in a horse with heaves. The breathing is labored, the throat swells, and there is occasional bleeding from the nose. If the hands are pressed over the ribs, there is usually evidence of pain due to pleurisy. There may be vomiting after fits of coughing. The animal will not move more than is necessary. The appetite remains better than in hog cholera and there is considerable thirst. The eyes show a more watery condition, and as a rule there is not as much skin eruption. Constipation is more frequently a symptom than diarrhoea.

Swine plague is especially fatal to old hogs. Both diseases may be in the same herd or in the same animal at the same time, still further complicating the symptoms. In nearly all cases where there is doubt, and a number of hogs are similarly affected in the same neighborhood, it is safe to conclude that one or both of these diseases are present. We have no other wide-spread disease of hogs causing such loss. The per cent of the herd that will be affected will vary in different outbreaks from ten to one hundred. One attack of hog cholera usually confers immunity against future attacks, so that it is advisable to retain

some of the best stock that recover for breeding purposes. Sows with pig usually lose them before maturity, and the first litter after recovery is weak. The attack does not confer any immunity upon the offspring.

Hog cholera is often mistaken for other diseases, as worms, diarrhoea or scours, septicaemia or blood poisoning, etc. Swine plague is frequently mistaken for pneumonia.

In some places the intestinal worms become so numerous as to cause all the intestinal symptoms usually described. Their will be loss of appetite, diarrhoea and vomiting, but as a rule no lameness, eruptions of the skin, gumming of the eyes, etc., found in hog cholera. The worms causing the trouble may be the large intestinal worms the size of a lead pencil, and two or three species of smaller worms from a half inch to two inches long. If a postmortem be held upon a case, and a careful examination be made, the difference can be positively determined. The presence of worms is such a serious trouble that some of the cholera cures are nothing but vermifuge powders, and in certain cases get credit for curing cholera. As an illustration of the loss occasioned by worms last year, one packing house estimated their loss upon sausage casings to be about $5,000. These hogs were not all obtained from Indiana, but it should offer a suggestion to observe more closely the cause of our losses.

Diarrhoea is often induced by changes of feed and the feeding of new corn. Diarrhoea, or scours, present almost the same symptoms as worms. The discharges are very fluid and often lighter in color than in cholera and do not have the same odor. In case of diarrhoea the change to a dry diet and proper feeding will usually bring about the desired result.

A form of septicaemia, or blood poisoning, sometimes attacks a herd of pigs, and being contagious spreads from one to another. It is characterized by gangrene, or the rotting of a part. It will rot the nose, mouth, lips, tongue, feet, or other parts of the body. The disease is usually localized; the line between the dead and the living tissue being fairly well defined. The disease presents some of the symptoms of cholera, but the localizing of the disease is usually sufficient to make a distinction in diagnosis.

Pneumonia, or lung fever, often occurs in hogs that are turned upon a stubble field or pasture during the hot months and the pigs have access to a cool stream fed by springs. The hogs get heated while grazing and go into the cold water to wallow. Pneumonia follows, and the symptoms are the same as for swine plague. The disease is not contagious. A separation of the hogs from the wallow is sufficient. Pneumonia follows when hogs pile upon each other in their bed during the winter. The under hogs become over-heated and when they go out they catch cold and pneumonia results. Pneumonia may also occur from being forced to inhale dust. The remedy for both these conditions will suggest itself to any intelligent mind.

MEDICAL TREATMENT.

There is a most urgent demand for a successful remedy for the treatment of hog cholera and swine plague. Veterinarians who have made a careful study of the action of drugs and of the character of the disease have tried everything that would seem to be a rational treatment, but they have found no specific. Pathologists have recognized the apparently hopeless condition to be treated and have been unable to suggest a remedy. Experimenters have tried everything which science and empiri-

cism has claimed could cure but they have found nothing which they could endorse as being successful. Notwithstanding all the futile efforts that have been made by careful conscientious workers, backed by large sums of money and every facility for investigation, we have *more than one hundred sure cure cholera remedies* sold in this state. According to their claims (and they are all alike) the prevention and cure of hog cholera is a very simple thing and depends wholly upon whether or not the farmer is willing to make the purchase of a few packages of their remedy. It is impossible to make a close estimate of the amount paid annually for such preparations, but it is certainly not less than $100,000 and some seasons probably reaches $300,000.

Last year I was engaged the greater part of the summer investigating the merits of these preparations. I found many of the preparations were the product of misguided men, wholly ignorant of the pathology of the disease and equally as ignorant of the action of the ingredients of their concoctions. From a very limited trial they had drawn a conclusion and sincerely believed they had discovered a sure cure and were willing to part with it for a large compensation. I have reason to believe that many of these men were honest but their observations were conducted upon too small a scale to draw proper conclusions. Their preparations will be upon the market a year or two and then be relegated to the same fate as has befallen many others.

A much larger number of these remedies are prepared by men or companies who know the power of a well worded advertisement and who are in the business for revenue only. They take the government formula and alter it in some slight particular, call it by another name and sell it for a dollar per pound, when the other could be obtained for one-tenth the price. Another favorite scheme is to take the formula of some of the old patented preparations and sell the preparation under a new name, well knowing that if it failed under the old name it could do no better under a new. I was informed that Brown county clay was sold as a remedy at seventy cents per pound. A third class of remedies are prepared by men who make a study of the disease. They constitute a very small minority.

The preparations used in the experiments were donated by manufacturers, the formula submitted and the preparation compounded in our own laboratory and by purchase in the open market. In all I secured 138 remedies and used 3700 pounds or nearly two tons of medicine. The plan was to test each remedy upon at least five herds in as many different localities and when possible to have an interval of time between the test so that it would be tried under all conditions. Without giving details of the work it may be said that the results do not warrant the recommendation of any one. Some are decidedly better than others but none will cure. Some were positively injurious. Nearly all the remedies would show some good effect upon some herd but would fail when tried upon a number. The good effects that come from the use of sure cures is due to the extra care that is taken. Whenever a man is willing to pay five or ten dollars for a cholera cure he begins to use more care in feeding, gives better protection and looks after the general surroundings. It is a notable fact that those remedies accompanied by the best directions upon sanitation when followed produced the best results. In this connection it is interesting to note that some manufacturers accompany their preparations with carefully compiled directions upon sanitation. It

must be confessed however that directions upon sanitation come high at fifty cents and one dollar per pound.

A letter was directed to a number of men who had endorsed certain hog cholera cures and among the interesting facts developed by the correspondence was that nearly all of them are agents.

Tests have been made at a number of places upon cholera cures. Last year Mr. John Cownie, of Iowa, made tests and made a report at the Iowa swine breeders' association that they were all failures.

Dr. Reynolds, state veterinarian of Minnesota, after examining the matter in that state, issued a circular to the press advising farmers not to purchase the remedies.

As far as a remedy is concerned we know of no specific, no sure cure. Some of them have a tonic effect and do a little good in that way. Some have vermifuge properties and thus remove one source of intestinal irritation. The remedy most imitated is the government formula. It is a tonic and bowel regulator and has given as much satisfaction as any. It is as follows:

Wood charcoal	1 pound
Sulphur	1 pound
Sodium chloride (salt)	2 pound
Sodium bicarbonate (baking soda)	2 pound
Sodium hyposulphite	2 pound
Sodium sulphate (Glauber's salts)	1 pound
Antimony sulphide	1 pound

The dose is a tablespoonful for each 200 pounds once a day. It is best given in sloppy food.

I had very fair results with the following in some of the experiments:

Chlorate of potash	1 pound
Bicarbonate of soda	1 pound
Nitrate of potash	2 pound

The dose of the above is a teaspoonful for each 200 pounds twice a day.

In case of constipation calomel is added for one dose at the rate of five grains for each 200 pounds live weight.

Another preparation which has met with some favor is chlorate of potash, a teaspoonful twice a day for each 400 pounds, and a teaspoonful of tincture of muriate of iron twice a day. The above preparations may be given in water or slop.

A common thing that proved more effectual than half of the proprietory remedies is kerosene, a half gallon to a barrel of water or slop. Allow the hogs to drink all they will.

Carbolic acid and like preparations are disinfectants and not cures. Their use will be discussed later.

One or two methods of treatment have been recommended that can not be passed over in silence. One is the burial of dead hogs and digging them up in a few days and feeding them to the survivors. This has been taught at our farmers' institutes and in the press. I have yet to learn of success by this remedy except from the man who originated the disgusting treatment.

Another is to boil the dead hogs and feed them, and a third is to take the blood from a hog, inoculate a worn out horse and kill it and feed it. Likewise these are reported as failures.

A final treatment is to pry open a hogs mouth and remove the papillæ on the inside of the jaw. The only effect is to abstract blood.

VACCINATION FOR THE PREVENTION OF HOG CHOLERA.

Vaccination has been employed as a means of preventing disease in the human subject ever since the time of Jenner. It has been used with marked success in the prevention of small pox and in stock it has been used as a prevention against anthrax. In France it is said that more than 6,000,000 sheep have been vaccinated against anthrax

and it is now possible to raise sheep where they could not be raised before. The signal success of vaccination in sheep has made many believe that similar results can be obtained by vaccination in hog cholera. The success of vaccination for the prevention of disease depends upon two things: First, that the disease when once withstood by an animal shall give immunity against future attacks, or that the contraction of a similar disease shall produce immunity from an attack; second, that the activity of the germ may be so reduced that it can be inoculated into an animal and produce a mild form of the disease In case of smallpox, physicians inoculate the patient with the germs from the cow and these produce a mild form of disease known as varioloid. This serves to give the individual immunity against the more virulent disease, variola or smallpox. In the case of hog cholera, one attack usually confers immunity against future attacks, but we have no allied disease of a milder form occurring in other animals from which we may obtain the virus and inoculate the hog and thus confer immunity. This is one of the obstacles to vaccination.

In the case of vaccination of sheep and cattle to protect them against anthrax the germs are grown outside of the body under unfavorable circumstances until their vitality is greatly reduced. They may then be introduced and produce a mild form of disease. The same method has been tried many times for vaccinating to protect against hog cholera but without success. Hog cholera can not be uniformly induced by inoculations of germs of hogs just dead from the disease, and therefore a mild form can not be induced by using an attenuated or weakened virus.

Some years ago Billings and others made great claims for vaccination and tried their experiments upon a very large scale. Their results were unsatisfactory, often having the effect of starting the disease where it did not exist before and they were soon compelled to give up the work. Some vaccination was practiced in 1896, but it was not more successful than that of a few years before. Vaccination in the hog fails because we can not get a virus from some other animal that will produce a mild disease and confer immunity and, second, because the germs can not be attenuated and inoculated and produce a mild form of disease. The fact that the disease has been introduced into herds where it did not exist before should make farmers very cautious about permitting any one to try vaccination upon their herds.

THE NEW ANTI-HOG CHOLERA SERUM.

The new serum treatment for hog cholera was given great publicity last fall and spring. This new treatment is like the anti-toxin treatment for diphtheria and is based upon a wholly different principle from that of vaccination.

It is a well established fact that in some bacterial diseases a strong resistance to the growth of the bacteria is developed by the formation in the blood of a substance known as anti-toxin. The germs form a poison or toxin and the blood forms the anti-poison or antitoxin. If the formation of the antitoxin is in sufficient quantity to overcome the toxin the patient recovers. It was discovered that if the blood of an animal that has recovered from disease be drawn from the veins and injected into the veins of another animal exposed to the disease it would prevent the latter from contracting the disease. It was also found that if the blood be injected into the veins of an animal affected with disease it would in many instances affect a cure. Advantage has been taken of

this curative property of anti-toxin in the prevention and cure of diseases, notably diphtheria

In order to secure anti-toxin for medicinal purposes it is usual to select some animal, as the horse, that does not naturally have the particular disease to be treated and inoculate them with the disease germs. A small dose is given at first. It produces a slight disease and as the animal recovers it gains some immunity. The dose is repeated at short intervals and is constantly increased until the animal can stand the injection, of probably five hundred times what would have been a fatal dose in the beginning. It requires several weeks to get the animal in this condition. In the case of the horse a gallon or a gallon and a half of blood may be withdrawn at a time, the serum separated and the anti-toxin used for the treatment of disease. This practice has been in vogue for a few years in the production of diphtheria anti-toxin. In 1896 Dr. Peters, of Nebraska, produced a hog cholera anti-toxin in the same way. Experiments were also made by the department of agriculture and last year they announced that they had been quite successful with its use, but the number of animals treated is too small to warrant drawing conclusions. This year the work is being conducted on a much larger scale and it is hoped that a conclusion may be reached this fall. Cattle and goats are being used in place of the horse in producing the anti-toxin. The animals used for this purpose must be perfectly healthy and given the best of care. They are bled about once every two weeks after they have become immune.

The anti-toxin treatment is costly because of the character of the material used in its production, the small quantity obtained at each time and the skilled labor required. It confers immunity for only a short time. This is not such a great objection as regards ordinary stock as they are soon placed upon the market. Unless it can be produced at small cost it will be of little use except for valuable breeding stock. The anti-toxin may be the best treatment we have but it does not promise all that is desired.

PREVENTION.

As we have no specific for the disease nor any course of medical treatment that is reasonably successful we must rely upon prevention. The disease can not be wholly prevented but a large per cent can be by individual effort and as much larger per cent could be by enforced measures. The means are sanitation and isolation. To enumerate all the sanitary measures would require a rehearsal of all the accessory causes. Only the more prominent ones will be considered here.

The most important consideration is the water supply. Surface water of whatever source is liable to contamination at any time. As long as it is free from disease germs it will do no harm, even though it contain 500,000 germs per cubic centimeter (half a thimble full). The fewer germs in water the purer it is, and a properly constructed well will not have more than a few hundred at most. The water should therefore come from a good well. If more good wells were used there would be less cholera and also less typhoid fever in the country. The water should be delivered to the hogs by stock fountains or by troughs so protected that the hogs can not get into it. The water should not be turned into ditches or holes in the ground no matter what the source.

The feed should be pure and wholesome. Pigs should not receive the slops from the kitchen and dairy that has been allowed to stand in a barrel in the sun

from three days to a week, until it becomes putrid. The slops from whatever source should be as sweet as can be had. In ordinary dish water there is so little nutrition that it had better be thrown away and pure water substituted. Moreover, the use of concentrated soaps and washing powders has been found to be the cause of death among pigs.

While corn will produce more weight in a given time than any other known feed, it is not a balanced ration and is very heating and not productive of strength. While the hogs are upon pasture they find the needed elements in the grasses to equalize this strong diet. When they are placed in the pen they should receive some additional food to act as a balance. It is not so important what the food is, so that the hog relishes it and thrives. As an adjunct a small quantity of oil meal always has a great effect, especially in keeping the bowels regulated.

Hogs are fond of charcoal and ashes and these seem to furnish something to the body that is decidedly beneficial. The cobs can be utilized in no better way than to rake them together once or twice a week and burn them to a char and adding about one-eighth or tenth as much salt. This seems to act as a regulator and tonic. Nearly all successful breeders follow this practice and some attribute the prevention of cholera to its use. The burning of the cobs has another beneficial effect, that of cleaning the yard of what soon becomes foul and a source of disease.

Another precaution that can be followed as a prevention of disease and also as an economical measure is the use of a feeding floor. It is not necessary that the floor should be of high grade lumber but of such material as will save the grain. The floor should be a little higher than the surrounding ground so that all cobs and filth can be removed at any time. These feeding floors are being used by many of the large feeders and soon pay their cost from the feed saved.

The bedding of hogs should be like that for other stock, a little at a time and often removed. There is no more reason why a fine sow should be made to wallow in her own filth than the carriage horse. The bedding of both will become foul and should be removed. It can not be kept pure by disinfectants. Hogs should have no bedding during the warm season, only a dry place on which to sleep. During the winter season there is as much danger of getting too much bedding as too little. At all events renew the bedding once or twice a week, and in case of a sow with young pigs, oftener.

In case of an outbreak of disease upon the premises separate the well hogs from the sick and confine all in small lots upon one part of the farm, but at some little distance apart. Separate the well hogs from the sick, as the contagion is spread by the droppings and excreta and the well hogs would be constantly subject to the contagion if kept upon the ground where the sick had been. Formerly the recommendation was made to give the hogs the benefit of a large pasture and keep constantly dividing the herd. Experience has demonstrated that this means has the disadvantage of getting the germs scattered over the entire farm, prolonging the disease, and is not more successful than dividing the hogs into two sections and after making the first division taking the sick out of the well herd as soon as the first symptoms are observed. The only precaution to be taken is to see that the hogs are in lots sufficiently large not to be overcrowded. The advantage of this method is that the disease is not spread over the entire farm, and the business of hog raising can be con-

tinued as soon as the outbreak is over. During the outbreak of the disease use plenty of disinfectants and when it is over clean and disinfect everything. Lime, chloride of lime, whitewash, carbolic acid, etc., are all good. Whenever possible have one man to handle the sick hogs and another the well hogs. Allow no visitors.

No rule can be given as to guidance when the pens, etc., may be used by fresh hogs. After disease, disinfection, etc., it is advisable to withhold hogs from the pens for six weeks, and unless business is urgent for a longer period. Whenever the disease occurs in the summer or fall it is better that the hogs be not kept in the permanent building but moved away and given temporary quarters with straw roof or other material that may be destroyed.

One precaution which it is well to observe in case of an outbreak of disease in a neighborhood, that the hogs be moved from fields adjoining a public highway. Experience has demonstrated that disease may often attack hogs along a public highway while those a little further removed will escape. The escaping of diseased hogs from a neighbor's pasture, the driving of diseased hogs to market, etc., are sources of contagion that threaten hogs when only a fence separates, but not when a field intervenes.

Hogs may be disposed of in two ways, by burial and burning. If by burial it should be well done, upon ground not used as a pasture, be at least four feet deep and a half bushel or more of quick lime placed upon every two hundred and fifty pounds of carcass. The quick lime is for the purpose of destroying the germs. Burning is the successful method and is not nearly as difficult as many suppose. The main thing is to keep the hog up off the ground. Four or five old rails under a hog will accomplish as much as twenty above and at his sides. All carcases should be disposed of as soon as possible after death so that nothing can carry pieces away. On the whole it will often be found to be as economical to kill badly diseased hogs as to have them linger along for a week or two and then die.

If a herd is in marketable condition and cholera makes an appearance it is best to send all the well hogs to market at once. Those that have the disease will be condemned by the government inspector and those fit for food will pass. The hogs should be hauled to market. This will result in some saving of loss to that particular herd and gets rid of one center of infection to a neighborhood. Such a recommendation is open to criticism from a scientific standpoint, but it seems to be the only practical recommendation that can be made under the present circumstances. Under no circumstances should hogs be purchased for feeding that have once passed through the shipping pens. These are the measures that may be taken by the individual. There are further precautions that should be taken by the state.

STATE CONTROL.

The argument is often made that the state should undertake some control over hog cholera and swine plague. The precedent is cited that the government stamped out pleuro pneumonia in cattle and has thus saved millions of dollars to the cattle interests. The different states take cognizance of glanders and some other contagious diseases and have limited the number of cases to very small numbers or stamped out the disease. The diseases which have been stamped out have been of such character as to require close contact to spread them. Hog cholera is of a different character and may start in a locality and spread without the animals

coming in close contact and is therefore not amenable to the same regulations. Typhoid fever in people sometimes assumes an epidemic character in cities, but by condemning all private wells and compelling people to use only a wholesome water supply the disease can be stamped out. Hog cholera is a water borne disease and could be lessened by using pure water, but it is also carried by other means and hence the control of the water supply is not sufficient. The suppression of cholera by state police control, as has been done in some diseases, is probably impossible; its reduction to a certain extent is altogether feasible.

We have little to guide us in what may be accomplished in this country. In England a great deal of work has been done upon swine fever and the results are very interesting. Prior to August 1896 the regulations were not very rigid, but at that time the regulations were changed and made very stringent so that all diseases had to be reported to the district inspector, all affected animals and all animals exposed to infection had to be killed, and hogs could not be moved from one district to another without a certificate; hogs could not be exhibited within sixty days after the disappearance of the disease from the premises, and all cars and other conveyances for hogs had to be disinfected after each trip. The outbreaks and hogs slaughtered each year since 1893 is as follows:

	Outbreaks.	Number Slaughtered.
1894	5682	56296
1895	6305	69931
1896	5166	79286
1897	2155	40764
1st 25 wks. '97	1434	25764
1st 25 wks. '98	1479	25882

After the work had been in progress for a year the Live Stock Journal, the most influential agricultural paper in England, commenting upon the great reduction in the number of outbreaks and in the number slaughtered, made the following statement: "Under these circumstances it would seem a very good opportunity to enact further restrictions on the movements which would tend to bring the disease into still smaller compass and then make a grand rush to stamp it out entirely when such possibility becomes within reasonable distance." Again in a subsequent issue the following appeared: "These figures show that a decided impression is now being made in the direction of diminishing the disease. The reports thus far this year show that the disease is being kept down to about the same number as last year. It will require three or four years more work before a conclusion can be drawn as to the possibilities of control by these means. The veterinary department claims a large saving for the amount expended in enforcing the regulations."

Last year our government undertook an experiment in Paige county, Iowa, to determine what might be accomplished by a sanitary police system. The plan was to make a canvass of a portion of the county and determine where and how many hogs had been lost from cholera the year before. Upon the report of an outbreak of disease the veterinarian visited the premises and condemned all that were sick and the owner was paid for all that was slaughtered. Disinfection and a general cleaning of the premises followed. Some remedies were tried. No official report has been published, but according to a paper read by Dr. Gibson, the state veterinarian, the results show that a large saving can be accomplished by killing and burning the sick and using sanitary precautions. The claim is made that the saving amply justifies police control.

Several of the states have laws upon

hog cholera, but they are, as a rule, confined to defining what disposition shall be made of the dead The enforcement of the law is delegated to no one and consequently little attention is paid to it. Minnesota probably undertakes more than any other state as the matter is in the hands of the state veterinarian and the state board of health. Canada demands a certificate from the state veterinarian before hogs can be shipped in. Recently two hogs were shipped from this state to Nova Scotia and were held up in Boston because no certificate had accompanied them.

In our own state we have a very imperfect law but one that has been productive of a great deal of good. In 1896 I was able to trace losses aggregating $8,000 to exhibiting swine at the state and county fairs. In 1897 disinfection was required; fifty-two out of fifty-seven fairs complied with the law and only two reports of contagion were received and the losses were small. Indiana breeders exhibiting in adjoining states where such precautions were not observed contracted the disease and brought it home to their herds. While the state is not enforcing the provision requiring disinfection of the cars we are receiving much assistance from the Bureau of Animal Industry. Under the direction of Drs. Turner and Armstrong cars bringing cholera hogs to the Indianapolis yards are required to be disinfected before leaving. A still further regulation should prevent the withdrawal of stock hogs for feeding purposes.

State control is an extremely large problem and will not be settled soon. To be successful it must meet the approval of the people. It will require a campaign of education through the press and the farmers' institutes to make them understand these diseases as they do glanders, sheep scab and some other diseases. It will require stronger demonstrations of the feasibility and economy of police control than any yet presented to cause its acceptance as the proper thing to do.

In the meantime the state should not be content to sacrifice $2,000,000 annually from loss by disease without making some effort to secure new facts or to distribute the information she now possesses. All the fund that is now used in investigating the disease is derived from the experiment station and is insignificant because the total for investigating all diseases is less than one thousand dollars and must be divided between several lines of work.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

BULLETIN No. 6.

ADDITIONAL INVESTIGATIONS

CONCERNING

INFECTIOUS SWINE DISEASES.

BY

THEOBALD SMITH, PH. B., M. D., AND VERANUS A. MOORE, B. S., M. D.

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., April 21, 1894.

Sir: I have the honor to transmit herewith the manuscript of the report which contains the results of some important investigations concerning infectious swine diseases. These investigations have been carried on for several years by my assistants in the laboratory and the present report contains results not heretofore published.

Very respectfully,

D. E. Salmon,
Chief.

Hon. J. Sterling Morton,
Secretary.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., March 31, 1894.

SIR: I have the honor to submit herewith investigations dealing mainly with problems relating to hog cholera and swine plague. They have been carried on since 1889, and have had for their object the endeavor to find out upon what factors the great diversity in the characters of infectious swine diseases depends. The problems have presented themselves in the course of the more important investigations on swine diseases already published, and a solution seemed essential to any further progress in this work. To the report is appended a brief résumé of the results obtained, together with suggestions as to future lines of work which are most likely to yield valuable results.

Respectfully,

THEOBALD SMITH,
Chief, Division of Animal Pathology.

DR. D. E. SALMON,
Chief of Bureau of Animal Industry.

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ADDITIONAL INVESTIGATIONS CONCERNING INFECTIOUS SWINE DISEASES.

THE HOG-CHOLERA GROUP OF BACTERIA.

By THEOBALD SMITH.

Now that authorities, especially the German, have satisfied themselves that the bacteria described in former reports of the Bureau as hog-cholera and swine-plague are really distinct species belonging to different groups, and that the somewhat labored efforts to re-examine the work in this direction have come to a close, we may be permitted to examine this important group of bacteria a little more closely and report on certain variations of the hog-cholera bacillus itself as encountered in different outbreaks. The necessity for more extended studies of allied bacteria forming well-marked groups is painfully evident as we read over the now voluminous literature of bacteriology. Especially with regard to the apparently spontaneous appearance of epidemics and epizoötics of infectious diseases and the interrelation of human and animal diseases, it is of the utmost importance to examine, not only bacteria actually found to produce disease, but also those which are evidently closely related to disease-producing bacteria in their morphological and biological characters.

VARIETIES OF THE HOG-CHOLERA BACILLUS.

Bacillus choleræ suis.—This microörganism was first encountered in 1885* and possessed the following characters, as determined at that time and subsequently:

Morphology.—A rod-shaped organism (bacillus) 1.2 to 1.5 μ long and 0.6 μ broad, with extremities rounded off. Spore formation not observed. It possesses the power

* Second Annual Report of the Bureau of Animal Industry (1885), p. 212. This organism was at that time called the swine-plague bacterium. The following year another organism was found in diseased swine so closely resembling the swine-plague bacterium, as described by Schütz in Germany a few months previous, that the name swine-plague was given to this second organism for the sake of uniformity of nomenclature and the old name "hog cholera" given to the bacillus described in this article. This change seems to have caused more or less misunderstanding and led to much misguided criticism.

of motion to an unusual degree. It stains readily in aniline dyes. In cover-glass preparations from the tissues of inoculated animals, the central portion of the rod is frequently only feebly stained.

Biology.—This bacillus grows fairly well on nearly all of the ordinary culture media, such as bouillon, gelatin, agar, milk, and blood serum. It thus possesses distinctly saprophytic properties. It is favored by the temperature of the blood and multiplies but feebly at 70° F. It fails to liquefy gelatin or to coagulate milk. It is destroyed in fluids at a temperature of 58° C. maintained ten to fifteen minutes.

Pathogenesis.—It produces in swine the infectious disease characterized chiefly by necrosis and ulceration of the mucous membrane of the large intestine and is occasionally accompanied by pneumonia of limited extent. It is fatal to rabbits, mice, and guinea-pigs in small doses, introduced either under the skin or into the stomach. In rabbits the disease is usually fatal in seven days when very minute doses are introduced under the skin. The period of disease may, however, be shortened *ad libitum* by employing large doses or injecting into the circulation directly.

Rabbits which have succumbed to minute doses show on post-mortem examination a small amount of suppurative infiltration at the place of inoculation. The spleen is engorged, the liver in a state of parenchymatous degeneration, and *contains small foci of necrosed tissue.* The kidneys are in a state of parenchymatous degeneration, the urine albuminous and containing hog-cholera bacilli. Peyer's patches may be pigmented and swollen. At the pyloric valve, the duodenum is frequently ecchymosed (probably due to discharge of bacilli in the bile). The heart muscle is markedly fatty, the lungs hyperæmic and frequently do not collapse when the thorax is opened.

More recently some additional characters have been determined which define still more narrowly its relation to other species and groups. Among these are the following:

1. The existence of a variable number of flagella. These have been specially studied in this laboratory by Dr. V. A. Moore.* He found most frequently 2 to 5, more rarely 8 or 9, flagella on a single organism. They vary in length, the more usual dimensions being from 7 to 12 μ. In one case a flagellum was found 18 μ long.

2. The fermentative action on dextrose in ordinary peptone bouillon. During the fermentation carbonic dioxide and hydrogen are evolved, and the fluid becomes markedly acid. Milk sugar and cane sugar are not attacked. Neither gases nor acids are formed in bouillon containing them.

3. A peculiar action on milk by which this fluid becomes opalescent and partly translucent.

We shall denominate the bacillus first described and subsequently encountered most frequently in outbreaks of swine disease as bacillus α and apply to the other varieties found other letters.

B. chol. suis β.—This variety was obtained from the spleen of a Nebraska pig early in 1886. It has been described in detail † in former publications and only a summary of its divergent characters is called for. One of the first things to arouse my interest was the bouillon culture. Within twenty-four to thirty-six hours after inoculation the fluid was covered by a thin, brittle, but complete membrane. The microscopic examination of such a culture showed that the bacilli in the fluid were of the same size as those of bacillus α and equally active.

* The Wilder Quarter Century Book, p. 355.

† Third Annual Report of the Bureau of Animal Industry (1886), p. 38.

n the membrane, however, the rods were evidently a trifle longer and ot in motion.

There was another peculiarity observed which is of considerable iterest. In making cultures on gelatin plates by drawing the platium wire dipped in bouillon cultures rapidly across the still soft gelan layer three or four times I observed that colonies of bacillus α ppeared within due time, while those of bacillus β on the same plate efused to grow. With a low power of the microscope, very minute olonies could be detected, which grew no larger. The difficulty was ound to be due to the fact that β requires a more strongly alkaline eaction of the gelatin than α. When this demand was satisfied the olonies grew even larger than those of α.

It is a curious fact that this variety, kept growing in the laboratory, nainly on agar, for over six years, still manifests these same peculiaries. It forms the membrane with the same rapidity, and unless the elatin is distinctly alkaline* the colonies do not appear. A comparion made in December of 1892 with a number of cultures from various utbreaks showed that while colonies of all the other varieties of the og-cholera bacillus appeared in gelatin rolls β refused to develop.

In order to make it grow sodium carbonate was added to the ordiary feebly alkaline beef-infusion-peptone gelatin and the result was uite striking, as the following notes show:

Na_2CO_3 in the form of a normal, sterilized solution was added to feebly alkaline utrient gelatin in different quantities:

a. To gelatin a, 0.025 per cent.
b. To gelatin b, 0.05 per cent.
c. To gelatin c, 0.075 per cent.

With these three sets of tubes rolls were prepared from the same bouillon culture. he first dilution was made in sterile water, the second and third in gelatin. The olls made therefrom will be denominated *A* and *B* respectively. In *B* the colonies ere few and became much larger subsequently than in the *A* roll.

th day. *a.* *A* roll, colonies 0.032–0.048 mm. diameter.
b. *A* roll, colonies 0.128–0.16 mm. diameter.
c. *A* roll, colonies 0.128–0.16 mm. diameter.

3th day. *a.* *A* roll; colonies of all sizes, from mere specks to such as large as in *b* and *c*.
B roll; only two deep colonies, each 1 mm. diameter.
b. *B* roll; deep colonies 1–1.25 mm. diameter, surface colonies 3–3.5 mm. diameter.
c. Same as *b*.

9th day. *a.* *B* roll shows more colonies than before; surface colonies as large as those of *b* and *c*.
In all *B* rolls the surface colonies have formed large expansions resembling those of *B. coli*.

6th day. *a.* In *B* roll surface colonies have spread out in the form of thin patches 10–15 mm. diameter.
c. In *B* roll they are more restricted, 5 to 6 mm. diameter, and fleshier.

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*The culture medium is made alkaline with sodium carbonate, the indicator being itmus paper. For beef-infusion-peptone gelatin about 40 cc. of the normal soluion is added to each liter.

The addition of the alkaline carbonate had thus the marked effect o causing the development of the colonies of β to such an extent tha they outstripped those of all hog-cholera colonies I have ever seen. I fact, the size of the surface colonies made me suspicions of some co tamination until the inoculation of a rabbit with a culture made fro one of these colonies, and various other tests, showed that my su picions were unfounded.

A further peculiarity of the growth of these colonies appeared in th gelatin rolls containing the smallest quantity of alkali. The colonie did not all appear at once and continue of the same size, as is univers in plate and roll cultures, but they appeared at intervals, so that, after time, a large number of colonies, greatly varying in size, appeare where only a few had started originally. Evidently the insufficien quantity of alkali added was responsible for this, for it did not occu in the rolls to which more alkali had been added. In these th appearance of the colonies was simultaneous, and they continued to b of uniform size.*

The pathogenic power of these bacilli, after artificial cultivation fo six and a half years, was not yet destroyed, for a rabbit which receive into an ear vein 0.12 cc. of a bouillon culture died in four days. The moti ity of this bacillus and the fermentative power in glucose bouillon we still present.

The pathogenic power of β was slightly less originally than that of α It was fatal to mice and rabbits, but two guinea-pigs resisted inocul tion. It was fatal to a pig when a large quantity of bouillon cultu was fed it.†

B. chol. suis γ.—Isolated from the spleen of a pig in 1890.‡ Thi variety is exceedingly interesting from the fact that its pathogeni properties are no greater than those of *Bacillus coli communis*. Tha is, it requires fully 1 cc. of a bouillon culture, injected into an ear vei to destroy a rabbit. It is introduced here for the reason that in mo phological and biological characters it differs but slightly from α.

Morphology.—In young bouillon cultures the bacilli appear slightly larger than α and sluggishly moving chains of several elements are common. In stained prepar tions the bacilli are slightly longer than those of α, measuring 1.8 to 2.5 μ. Eve filaments 4 to 8 μ in length were occasionally detected after the bacilli had bee cultivated several years.

Biology.—The gelatin colonies are of the very delicate, spreading type, with marked bluish cast in transmitted light. They do not attain a greater diamet than 2 mm., and resemble closely colonies of *Bacillus typhi abdominalis*. The bouillo culture becomes very turbid and has a faint odor.

Pathogenesis.—Feeble or absent.

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* Colonies varying in size are also observed on plates made from cultures whi have been subjected to the action of acids arising from fermentation.

† Loc. cit., p. 43.

‡ Report on Swine plague (1891), p. 77.

B. chol. suis δ.—Isolated at the same time with bacillus γ.

Morphology.—In general like α, though the bacilli appear a trifle plumper.

Biology.—Bouillon cultures become quite turbid. In the earliest cultures the cilli formed clumps which in the hanging drop moved about as single masses. iis peculiarity maintained itself for months and after passage through several rab-ts. At present it seems to have disappeared.

Pathogenesis.—Quite feeble, perhaps a degree below that of β. The bacillus seems have no effect on pigs.*

B. chol. suis ε.—This variety, obtained from a Virginia outbreak in 90, agrees entirely with α in all but two features:

The surface colonies on gelatin plates instead of having the slightly nvex form of α spread out in somewhat thinner, more or less bluish itches with sharp, undulating border, in this regard approaching the npathogenic variety, bacillus γ. A second differential feature is e viscid condition of the colonies and of the diffuse growth on agar. hen this is touched with the platinum needle a delicate thread may drawn out several millimeters in length. This peculiarity at first d me to suspect the purity of the culture. After making repeated ate cultures and passing the culture obtained from colonies through bbits the same viscidity reappeared. It has persisted in cultures to the present.

B. chol. suis ζ.—This interesting variety of the hog-cholera bacillus as obtained from cases of disease early in 1889. The outbreak pre-nted a number of characters not noted in outbreaks examined up to at date. These have been very briefly referred to in former publica-ons.†

Morphology.—This variety differs from α in appearing a trifle larger. In attempt-g, however, to present this impression of the eye in figures, I found it impossible determine any difference, probably owing to the still crude state of the present icroscopic measuring apparatus. It is not uncommon to find longer filaments in e various culture media, some of which show active movements.

Biology.—This variety may in general be regarded as nearer the saprophytic stage, r it grows more vigorously than α in the various culture media.

In gelatin plates and rolls the colonies appear within forty-eight hours, and at the d of a week develop into circular, smooth, glistening discs, which are grayish white d exhibit at times faint, concentric markings. When 1 or 2 cm. apart, they may be or 4 mm. in diameter. The deep colonies are brownish, finely stippled spheres d attain a diameter of 0.4 to 0.5 mm. when not crowded. They thus resemble lonies of α in form and appearance, but are much larger.

The inclined agar growth differs from that of α only with reference to several inor points. The growth on the surface is the same with both germs, while in the ndensation water there is a more active multiplication of the second germ, and e water assumes a milky white appearance. In cultures of α the liquid is not ilky white, as the multiplication is far less active. In alkaline bouillon and bouillon ith peptone this germ develops more rapidly and abundantly than does α. The quid becomes very turbid over night in the thermostat and on shaking it a partly anular partly flocculent deposit arises. Careful inspection shows in some cultures very delicate, iridescent pellicle on the surface. Multiplication was also observed

* Bulletin on Swine Plague, p. 80.

† Report of the Secretary of Agriculture for 1889, pp. 75–79.

in hay infusion. This was most vigorous when the hay infusion was made slightly alkaline.

On potato the growth resembles that of α very closely; it is perhaps of a more decided pale yellow than the latter. This description applies to cultures on pieces of potato in tubes from which evaporation is excluded. On some kinds of potato the growth is very feeble, whitish, and glistening, and easily overlooked. Bacillus ζ seems to be less sensitive to the reaction of bouillon. An abundant growth was obtained by adding to 10 cc. of the ordinary acid bouillon (not neutralized) a drop of lactic acid; α under the same conditions multiplies very feebly. This indifference to acid media may account for the fact that in the outbreak from which this variety was obtained the stomach was frequently attacked by necrotic and diphtheritic changes.

Pathogenesis.—This bacillus differs quite markedly from α in its virulence. The difference is best demonstrated by the inoculation of rabbits. A quantity of bouillon, less than one-fourth cc., did not prove fatal when injected subcutaneously, and in some cases even larger quantities were required. An early experiment with α showed that a dilution equivalent to $\frac{1}{4000000}$ cc. of a peptone bouillon culture injected subcutaneously is still capable of proving fatal to rabbits.

While this comparatively large dose was required when injected subcutaneously, it was found in subsequent vaccination experiments with this variety that an equivalent of 0.02–0.01 cc. proved fatal when injected into an ear vein. The general character of the disease as revealed at the autopsy was likewise different from that produced by α. It lasted nearly a week longer. The spleen was not enlarged; the necrotic foci were not found in the liver; there was no hemorrhage in the duodenum, but, on the other hand, a striking disease of the intestines was present. The Peyer's patches of the small intestine were very much thickened and appeared as aggregations of whitish dots. The mucous surface over these patches was not infrequently covered by a slough. In the appendix vermiformis, part or all of the solitary follicles were enlarged, whitish, nodular, occasionally ulcerated. The Peyer's patches at the ileo-cæcal valve—one in the ileum, the other in the cæcum—were, as a rule, much thickened and covered by sloughs. In several cases the mucosa of the cæcum was covered with ulcers, probably due to bacilli discharged from the ulcerating Peyer's patches and localized here. The bacilli were readily demonstrated in the form of clumps in the infiltrated Peyer's patches and in some of the internal organs. The disease might be denominated typhoid fever of rabbits.

These various lesions did not always appear together in the same animal. Sometimes the ulceration was extensive, sometimes there was only swelling and infiltration of the follicles and Peyer's patches. Sometimes the disease was unusually prolonged. In one case, in which an ear vein injection had partially failed, the animal lived thirty-two days. All the solitary and agminated follicles of the intestines were found enlarged and infiltrated. The mucosa covering the patch in the ileum at the valve was necrosed.

In all cases there was a continuous elevation of temperature, the height of which varied with the intensity of the disease process, as gauged by the dose injected.

Feeding rabbits proved negative. The following experiments show that this variety affected mice, guinea-pigs, and pigeons:

Guinea-pig.—June 1, 1889. Two guinea-pigs received subcutaneously one-fourth and three-eighths cc., respectively, of a turbid peptone bouillon culture. The first guinea-pig died June 7. The chief lesion consisted in a sanguinolent and suppurative infiltration of the inoculated thigh, extending over the scrotum upon the other thigh. In the spleen a moderate number of bacilli. The second guinea-pig died June 10. There was a large ruptured abscess in the right groin. In the abdomen Peyer's patches are inflamed and thickened, the mesenteric glands infiltrated.

Pigeon.—May 27. Four pigeons were inoculated by partly subcutaneous, partly intramuscular injections of peptone-bouillon culture liquid over one pectoral muscle. Two received one-half cc. each, two three-fourths cc. Of these but one, which had received one-half cc., died on the following day. On the inoculated side the

major portion of the pectoral muscle appears pale and necrosed. The internal organs present nothing abnormal. Bacilli present in the blood. In the other pigeons superficial sloughs formed in the pectoral muscle.

Gray mouse.—May 17. Three mice inoculated, from the same culture used for the pigeons, by subcutaneous injection of one-twelfth, one-eighth, and three-sixteenths cc., respectively. The third mouse dead next morning. The only discoverable lesion was the distension of a portion of the small intestine with a dark red mass, probably blood. The first mouse dies in about twenty-four hours with similar lesion. The second mouse was found dead on the seventh day after inoculation. The spleen was considerably enlarged and contained many bacilli. In the small intestine yellowish liquid contents. Peyer's patches appear from serosa as aggregations of blood-red dots. Culture on agar from the spleen pure.

Feeding mice.—Two mice were starved for a day, then fed with bread crumbs upon which the condensation water from the bottom of an agar culture had been poured. Both mice were sick next day and one died about noon. The spleen was very much engorged. In the small intestine a blackish, semiliquid mass (hemorrhage). No bacilli could be seen in preparations from liver and spleen. The second mouse survived this feeding as well as a second feeding attempted two weeks later. Two mice were fed in the same way a week later. Next day both were found lying on their backs, feet extended, breathing slowly and with difficulty and opening their mouths as if gasping for breath. Brought near a hot register they speedily recovered and were quite active the remainder of the day. On the seventh day both sick again and one died on the eighth day. In the slightly enlarged spleen hog-cholera bacilli were present, as demonstrated by an agar culture.

Bacillus ζ produces in swine a true hog cholera. The chief lesions are in the large intestine and in the stomach. In the outbreak in which this bacillus was encountered there was also found extensive broncho-pneumonia associated with swine-plague bacteria and lung worms. In pigs penned with those obtained from the outbreak the disease assumed a more decidedly intestinal type, the pneumonia disappearing. As the subject is of considerable importance the notes on three pigs of the original herd and of three of those infected by them are given in an appendix to this article.

The disease induced by ζ is more prolonged, more chronic than that produced by the virulent type, α. About four weeks elapsed between infection and death. The lesions of the stomach consisted of necrotic and diphtheritic changes of the mucosa usually outside of the fundus. In the large intestine the destruction of the mucosa was very extensive. The process was partly necrotic, partly exudative in character. The mucosa in the cæcum and upper colon was converted into an amorphous, whitish layer with irregular surface which I compared in the preliminary note to cork lining in appearance and texture. In the language of pathologists it would be called branny, i. e., as if bran had been sprinkled over the surface in a dense layer. Farther down the necrosis was less diffused, more localized, and now and then replaced by a true exudate, easily removed from a surface apparently but slightly altered. Large, button-shaped, neoplastic growths were encountered in one case of the original diseased herd.

The reduced virulence of bacillus ζ as compared with that of bacillus α was furthermore demonstrated by the feeding of cultures to pigs. Only softening of the feces and marked debility with loss of appetite were noticed for several days after the feeding, with the exception of one case, which proved fatal.

May 14, 1889. Pig No. 198.—Received three days ago from a farm upon which no swine diseases have existed for a number of years. Starved since yesterday morning. To-day a pint of a 4 per cent solution of crystallized sodium carbonate given to it of which only a portion is consumed. One hour later it is drenched with 100 cc., or nearly 1 pint of a bouillon culture in which bacillus ζ (derived from a colony in a gelatine roll) has multiplied for four days. The pig is not fed until next day. On the second day diarrhea sets in and the feces have a grayish color. Small quantities of a viscid yellowish mucus containing whitish flakes, are vomited occasionally. This condition persisted until death ensued quite suddenly four days after the feeding.

The autopsy was made 36 hours after death. The animal in the meantime was kept in the refrigerator. Male pig about 3½ months old. No skin lesions observed. On back of tongue near tip a group of whitish spots as of beginning necrosis. Stomach

contains about a pint of yellowish flaky fluid. Mucosa over one-half of fundus dark red, swollen, and covered by a paper-like layer of a dull color. Around the cardiac expansion of œsophagus the mucosa has a dull yellowish appearance as if superficially necrosed. In the small intestine the inflammation progresses in severity from above downwards. This inflammation is manifested by increasing hyperæmia and injection of minute vessels, and by a tumefaction of Peyer's patches. In the ileum the walls are thickened and the reddened mucosa is covered with a thin layer of a yellowish white pasty exudate containing large numbers of leucocytes. The large Peyer's patch near the valve is partly hemorrhagic. In the large intestine the mucosa is reddened in patches, the walls of the gut thickened. The follicles in the lower colon appear with a central white point. When compressed these points are shown to be openings from which a plug of creamy matter exudes.

The urine in the bladder contains a trace of albumen and a large deposit of crystals of calcic oxalate.

From the spleen, slightly augmented in size, cultures were made, but remained sterile. From the mesenteric glands gelatin roll cultures and a bouillon-peptone culture were made. In these the fed hog-cholera bacilli developed.

Taking into consideration the pathogenic action of this bacillus on swine and on the smaller animals experimented with, no one will, I think, hesitate to accept the conclusion that bacillus ζ is a true hog-cholera bacillus closely related to or even specifically identical with bacillus α and that further experimental investigations are not called for to fortify this conclusion.

Five years ago, when this organism was first isolated, the attitude of bacteriolgoists, especially of the Koch school, was somewhat reserved in acknowledging the possible existence of distinct varieties of the same pathogenic species. In view of this a series of experiments were carried out to determine whether rabbits could be protected from the disease induced by bacillus α after passing through the disease produced by minute nonfatal doses of bacillus β. These results are briefly sketched on p. 43. They may be summarized as follows:

1. When α was reduced in its virulence the rabbits inoculated with it frequently presented the same gross lesions produced by β.

2. When rabbits were made partially insusceptible by inoculation with attenuated cultures of α and then inoculated with a virulent culture of α the resulting disease resembled that produced by β.

3. Rabbits which survived two inoculations of β were protected from a fatal disease when inoculated with α.

B. chol. suis η.—This variety was isolated by Dr. Moore in 1891 from the organs of a pig. It has been fully described in Bulletin No. 3 of this Bureau, and the reader is referred to that publication for a detailed account of its characters. It closely resembles α in all but one particular. It is nonmotile. This variation, apparently of such great morphological significance, is scarcely reconcilable with the close relationship existing between η and α in all other respects. Possibly η is a modification of α and originated at the Experiment Station of the Bureau where the pig was kept. Between 1885 and 1890 a large number of swine succumbed to experimental hog cholera at the station and it is not improbable that a few individuals of α may have survived in the soil or the body of insusceptible pigs where they gradually lost their motility. We know that motile bacteria may lose their motility wholly or in part in artificial cultures.

OTHER BACILLI, NOT FOUND IN OUTBREAKS OF HOG CHOLERA, WHICH BELONG TO THE SAME GROUP.

*Bacillus found in a mare after abortion.**—This organism must be grouped with the true hog-cholera bacilli. The only recognizable differences were a tendency of the colonies in the earliest cultures to flow partly down the inclined agar surface, and a feebler pathogenic power than that of *Bacillus chol. suis α*.

It is obvious that these minor variations are not of sufficient importance to separate this bacillus from the hog cholera group.†

Bacillus enteriditis, Gærtner.—This organism was found in 1888 by Gærtner in Saxony under circumstances which are of sufficient importance to deserve a somewhat extended quotation:‡

A cow, suffering with diarrhea and discharging mucus, was killed and pronounced fit for food. The autopsy revealed nothing abnormal beyond reddening of the small intestine. The flesh appeared normal and was free from odor.

A young, strong workman ate 800 grams (less than 2 pounds) of this meat raw, and seasoned with pepper and salt. He became ill two hours later, with vomiting and diarrhea, and died in about thirty-five hours. The autopsy showed inflammation of the small intestine. It was reddened and distended with gas. The solitary and agminated follicles were swollen, whitish, the mucosa in places infiltrated, whitish, in others reddish; the vessels markedly injected. In the stomach the fundus was hemorrhagic.

The meat had been put on sale May 11, and up to May 18 fifty-eight persons belonging to 25 families became ill. All of these with one exception had eaten of this meat. This person, the mother of the deceased young man, may have accidentally infected herself with his discharges.

Of the 57 persons affected 12 had eaten the meat raw, 10 had eaten fried and boiled liver, 2 a dish made from the lungs, 29 had taken boiled meat and soup, and 3 soup only.

All persons who had eaten raw meat became ill, while of those who had consumed cooked meat and soup about 36 remained well. The severity of the attack was proportional to the quantity of raw meat eaten. Thus, 1¾ pounds caused death in thirty-five hours, while one-fourth pound led to a disease lasting fourteen days. In case of the cooked meat and soup no such relation was noticed. The disease produced was either very slight or severe and protracted.

There was no noticeable difference observed with reference to sex and age. The disease appeared in most cases within twenty-four to thirty hours with nausea, vomiting and purging; the vomited matters were frequently bloody, the stools greenish and mucous. These symptoms were followed by severe general disturbance, such as loss of consciousness, fever, and rapid, weak pulse, associated with great prostra-

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*Bulletin No. 3 of the Bureau of Animal Industry, p. 53.

†The tendency of the colonies to run is easily accounted for by an increased production of a viscid substance around the bacilli. When sufficiently insoluble it becomes visible as a capsule in some species. In certain bacteria cultivated for a long time on agar the tendency to produce this substance seems to become augmented and a culture originally not viscid may become so after one or more years of cultivation on alkaline agar. In the variety under consideration this tendency of the colonies to run down the agar surface was transformed later into a tendency to form a slightly wrinkled membrane. At present even this feature is no longer recognizable.

‡Corresp. d. allg. ärztl. Vereins Thüringen, 1888.

tion. Recovery took place in from five days to four weeks, according to the severity of the attack. During convalescence the epidermis peeled off.

In the flesh and the organs of the diseased cow and in the spleen of the deceased person the same bacillus was found. In the description of this bacillus by Gærtner no characters are recorded which separate this organism from the hog-cholera group as extended by the varieties previously described, excepting perhaps an unusually coarse granulation of the colonies on gelatin. Unfortunately, no mention is made of the action of this bacillus on milk.

The tests of this bacillus on animals showed both toxic and pathogenic action, and demonstrated the varying susceptibility of different species to this virus. Dogs and cats remained well after consuming freely of this meat. Similarly a fowl and sparrow were not affected after eating cultures of this organism. Gray and white mice fed with cultures died in from one to three days. Rabbits died after subcutaneous inoculation with particles of infected cow's flesh in from eight to twenty days. Guinea-pigs similarly treated recovered. Cultures acted in the same way.

In the inoculated animals the small intestine was usually filled with a thin, greenish-yellow fluid, and in some rabbits a glassy mucus was discharged. After intraperitoneal injection, fibrinous exudates, chiefly on the liver, were the rule. Occasionally the pleura was affected like the peritoneum. Not infrequently hemorrhages appeared, especially under the serous membranes. The local lesion was followed by very firm infiltration of the skin and subcutis, gelatinous œdema, and suppuration.

Gærtner further showed that meat in which these bacteria had multiplied, and which had been subsequently boiled to sterilize it, was very toxic and when fed to guinea-pigs and mice caused death. The same was true of the bouillon made from such infected flesh. In rabbits the poison did not act when introduced into the stomach.

Karlinski * describes a case of meat-poisoning, which he refers to *B. enteriditis* as the cause. It is a custom in Herzegovina to keep on sale, under the name *suche mieso* (dried meat), large portions of the carcasses of sheep and goats dried in the sun. This meat, although exposed to dust, sun, and rain for months, and although it is tasteless and has a penetrating rancid odor, is a favored article of diet among the poorer classes.

In May, 1889, a healthy man ate, as a result of a wager, 400 grams (somewhat less than a pound) of this dried meat softened by soaking beforehand. Within two hours nausea, vomiting, and purging set in. The temperature rose, the pulse became rapid and feeble, and the abdomen painful. Later, clonic spasms of the upper extremities, cold perspiration, and slight dilatation of the pupils were noticed. The temperature remained high for five days, then recovery slowly took place. The epidermis peeled off on the neck and extremities.

Karlinski isolated *B. enteriditis* from the vomited masses and from the dejections. Intravenous injections of this bacillus in small doses into quite young goats and lambs resulted in general depression and diarrhea, followed by death in five days. Karlinski furthermore isolated this organism from several pieces of dried meat, from the intestines of several human beings, and a goat. From these encounters he draws the conclusion that *B. enteriditis* is a widely distributed organism.†

Lubarsch ‡ describes a bacillus in connection with a fatal disease in a new born child, which he is inclined to consider identical with *B. enteriditis*. There is, how-

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* Centralblatt f. Bakteriologie u. Parasitenkunde, VI (1889), S. 289.

† Karlinski's frequent encounter of this bacillus raises the suspicion that he may have, at least in some cases, confounded it with varieties of *B. coli communis*. Our own experience is that bacilli of the hog-cholera group are very rare and isolated with great difficulty when saprophytic forms are also present.

‡ Arch. f. pathol. Anat., CXXIII (1891), § 70.

er, one fact stated in the printed observations which militates against this posi-
on, namely, the coagulation of milk. The results of inoculations on smaller animals
e not very precise, the doses being chosen too large. Thus, the intraperitoneal
jection of several cubic centimeters of a bouillon culture of the widely prevalent
coli communis is likely to prove fatal in twenty-four hours. I have found 5 cc. of
culture of *B. coli* even after sterilization at 60° C. injected into the abdominal
vity of guinea pigs prove fatal within twenty-four hours in some instances.

A culture of *B. enteriditis* from Král's laboratory in Prague, Austria,
as studied by the writer in 1893. The results of the examination are
iefly as follows:

In gelatin rolls the surface colonies (3–10 mm. apart) were about 1 mm. in diam-
r on the fourth day. They appeared as slightly convex, round masses, coarsely
ppled when viewed under a low power. The deep colonies on the same plate
re opaque, brownish spheres 0.25 mm. in diameter. Little change took place in
e rolls subsequently. In the gelatin stick culture the needle track developed into
light growth in three days, the surface expansion was feeble.

On inclined agar a grayish, glistening smooth surface growth and opaque whitish
posit in condensation water not at all characteristic or peculiar.

Peptone bouillon became very turbid in three days. Odor feebly sour.

Milk was not coagulated.

On potato a dry, brownish-yellow growth had appeared in three or four days.

The bacilli from agar cultures are quite small and short; those from bouillon
ry more or less in length and thickness. From potato they are very short, almost
al in outline.

In bouillon they are actively motile during the first few days, later on many are
thout motion. From an agar and a potato culture four days old they were non-
otile. Their behavior towards sugars does not differ from that of the true hog-
olera bacilli.

These morphological and biological characters are practically identi-
l with those of the hog-cholera bacillus. The inoculation of rabbits
ewise confirms this relationship.

uly 12, 1893. White female rabbit, weighing 2¼ pounds, receives into an ear
n about 0.12 cc. of a bouillon culture twenty-four hours old.

uly 16. Rabbit found dead this morning. Spleen moderately enlarged, dark,
newhat softened. Coccidiosis of gall bladder. No necrosis in liver. Kidneys
e. In appendix of cæcum a few enlarged whitish follicles. Quite a number of
licles of the lymphatic patch in cæcum near valve enlarged, whitish. Bacteria
spleen demonstrated by the microscope and in cultures.

July 12, 1893. White female rabbit, weighing 2¾ pounds, receives into an ear
n 0.24 cc. of the same culture.

July 14. Dies this morning. Spleen soft, dark, moderately engorged. Kidneys
peræmic; pale striæ in base of pyramids. Lungs hyperæmic. In spleen pulp a
all number of bacteria resembling the hog-cholera bacillus closely. Cultures
de therefrom contain this injected organism only.

The lesions of the intestines in the first rabbit resemble those produced by *B. chol.
s β*.

Bacillus typhi murium.—In October of 1890 this organism was found
Prof. Lœffler, of Greifswald, as the cause of an epizoötic among
ite mice kept for experimental purposes in cages at the Hygienic
stitute. For account of the use of this bacillus in the destruction of
ld pests see the Annual Report of the Department of Agriculture for
93 (p. 155). The description which Lœffler gives of this bacillus cor-

responds so closely with one or the other of the varieties of the hog-cholera bacillus that a detailed repetition of his statement is not called for. The only differential characters requiring mention are the following:

Milk is stated to become distinctly acid, but to remain unchanged in appearance.

Guinea-pigs were slightly more susceptible to subcutaneous inoculation than rabbits. The latter reacted with a local abscess only. Two pigs, 4 weeks old, were fed with large quantities of bouillon. One remained well, the other died in eight days of an intestinal catarrh. Although Lœffler is inclined to regard this death as due to some other cause, our experience would incline to the belief that the feeding was responsible for it. A culture of this bacillus from Krâl's laboratory, examined in 1893, presented the following features:

In gelatin rolls the colonies appeared in two days. On the fourth day the surface colonies (one-third to 1 cm. apart) had expanded so as to be 3 to 4 mm. in diameter. The outline of the expansion was roundish, the margin delicately notched. The expansion was of nearly uniform thickness without central knob, the color grayish, partly translucent. In some colonies there were faint indications of concentric zones of slightly varying opacity.

The deep colonies were spheres, about 0.5 mm. diameter, brownish, without coarse markings. In rolls containing many crowded colonies, a distinct peripheral zone appeared.

The gelatin stick culture developed a slight growth in the needle track and a thin limited surface expansion.

On inclined agar, the appearance is the same as for *B. enteriditis*.

Peptone bouillon became exceedingly turbid in three or four days.

Potato culture precisely as that of *B. enteriditis*.

The bacilli in bouillon appeared as plump rods with rounded ends, some being mere ovals. From agar they appeared as small as hog-cholera bacilli.

The motion in bouillon twenty-four and seventy-two hours old was very active. All appeared to be in motion. From agar about one-third were in motion. From potato culture four days old only Brownian motion detected.

Milk was not coagulated.

The fermentative properties were identical with those of the hog-cholera bacilli.

The following experiments on animals were made:

July 15, 1893. Female rabbit, weighing 6 pounds, received subcutaneously 0.3 cc. of a bouillon culture one day old.

July 18. Temperature 104.6° F.

July 22. Temperature 102.8°. Small local abscess. Another rabbit which had received only 0.12 cc. of the same culture reacted in precisely the same way.

July 10, 1893. A rabbit received into an ear vein 0.12 cc. of a bouillon culture six hours old.

July 11. Temperature 106.4° F.

July 12. Rabbit very ill; lies flat on abdomen, with head extended on floor of cage.

July 14. Dead this morning. Spleen very dark, soft, moderately enlarged. Liver and kidneys quite pale. Lungs hyperæmic. Heart contains thick blood.

In spleen and liver many bacilli, usually in pairs and with a feebly-stained interior like hog-cholera bacilli.

Two gray mice fed with bread soaked in bouillon cultures on three separate occasions showed no signs of illness.

This bacillus, nevertheless, possesses a considerable degree of patho-enic power. In some inoculation experiments on guinea-pigs, made ecently by Dr. C. F. Dawson under my directions, it was shown that hile the guinea-pig withstood rather large subcutaneous doses (0.3 cc. f a bouillon culture) it was very susceptible to minute intraabdominal oses. In a more recent comparative experiment I found 0.02 cc. of a ouillon culture of *B. typhi murium* fatal within twenty hours when ijected into the abdomen. The same dose of virulent hog-cholera acilli injected in the same way proved fatal in not less than four days.

Another bacillus* recently described by Laser as causing epizoötics mong field mice seems to belong to this group and to be perhaps losely related to *B. typhi murium*. A culture of this organism was not ccessible for examination and comparison. Laser mentions that his acillus produces acids in litmus whey equal in quantity to that pro-uced by Emmerich's bacillus. This fact would group this bacillus ith *B. coli*, for the hog-cholera group does not produce any acid in ërobic cultures of lactose bouillon recognizable with litmus paper. trangely enough, no statement is made concerning its behavior in ilk. A further differential character consists in its taking the Gram tain.

This bacillus appears to be more promptly fatal than hog-cholera acilli, for both a field and a white mouse died in forty-eight and thirty-x hours, respectively, after subcutaneous inoculation. Feeding estroys the same species in four to six days. Similarly some rabbits nd guinea-pigs proved susceptible. Neither the degree of suscepti-ility of these animals nor the pathological changes found at the autopsy ave been sufficiently elucidated to be available for comparison with e hog-cholera bacillus.

A possible member of this group may be the bacillus found by Loeffler 1881 as the presumable cause of diphtheria in pigeons.†

The disease had destroyed a flock of about 20 pigeons and only one ase, the last, came into Lœffler's hands. He describes the sick pigeon s sitting trembling, with ruffled feathers and half-opened beak. The orners of the mouth, the base of the tongue, and the palate were covered ith yellowish deposits. The dung was semifluid. The animal took o food, but drank much water. Death occurring during the night, he autopsy next day showed in addition to the deposits in the mouth yellowish membrane extending through the trachea into the bronchi. n the lungs there were several pneumonic foci; there was parenchy-atous clouding of the liver, slight enlargement of the spleen, occa-ional hemorrhages under the capsule of the kidneys. The mucosa of he intestines was markedly reddened and sprinkled with hemorrhages.

* Hugo Laser, Ein neuer für Versuchsthiere pathogener Bacillus aus der Gruppe er Frettchen-Schweineseuche. Centralblatt f. Bakteriologie, XI (1892), S. 184, III (1893), S. 643.

† Arbeiten a. d. kaiserl. Gesundheitsamt, II (1884), S. 482.

The bacilli were found in the false membranes and in groups in the liver. The description is very meager. The inoculation of white mice is in so far interesting as it led to a fatal disease closely resembling that produced by hog-cholera bacilli in gray mice. The period of disease lasted from four to eight days. The spleen became very large and the liver mottled with necrotic foci.

GENERAL CHARACTERS OF THE HOG-CHOLERA GROUP OF BACTERIA.

After having given in brief a general description of the various members of the group of hog-cholera bacilli, we will bring together in compact form the underlying characters which bind the members of this group together, and those minor differences by which they have been individually differentiated. It should be stated that the following statements are based on an extended comparative study of these varieties, cultivated at the same time under precisely the same conditions. The microscopic observations were made only on groups of cultures prepared in this way. Careful measurements of the growth of colonies on gelatin plates have also been made, but the results, although showing well-marked constant differences, were not thought of sufficient importance to be given *in extenso.*

Morphology.—In form they are closely related. They are short rods with ends rounded, not producing spores, and possessing the power of motility with one exception (η).

More closely scrutinized they exhibit, in cultures, a certain divergence in size, which it is difficult to define. Thus bacillus ζ is evidently a trifle larger than α. In the membrane formed by β on bouillon the bacilli are longer than those in the bouillon and longer than α. The nonpathogenic form γ is distinctly larger than α, and cultures contain filaments of considerable length. Again, the swine-pest bacillus and the abortion bacillus resemble α very closely morphologically. *B. typhi murium* appears a trifle larger and plumper than α, and *B. enteriditis* inclines to involution forms.

Not only is it difficult to draw a sharp line when cultures of the same age and in the same medium are examined, but it is well nigh impossible to do this when various media are used. The different varieties vary in size from one medium to another, and any differences gained by the study of cultures in the same medium may be effaced by an examination extended to several culture media. The age of the culture as expressed by the time which has elapsed since its isolation from cases of disease may and does induce certain modifications of form not readily described.

In stained cover-glass preparations from the organs of inoculated animals, more particularly the spleen of rabbits, they resemble each other very closely. They usually present a more deeply stained periphery and give the impression of a bacillus completed filled out by a feebly-stained spore. This character, which I first pointed out in 1885, when taken together with their appearance in pairs is of considerable specific value. It is not always noticed in the most virulent varieties.

All the varieties which have been studied are capable of spontaneous motion excepting bacillus η. There is, however, no valid reason beyond this for excluding the latter from this group. In fact, setting this aside, it resembles α as closely as any other variety does.

Biology.—All varieties described fail to liquefy gelatin and as a rule grow with much less vigor on gelatin than the related group of *B. coli communis.* There exist among them 3 types of growth of the surface colonies on gelatin:

1. That of the virulent form α, the variety ζ, and *B. enteriditis*, consists of slightly

onvex, roundish patches, varying in size according to the variety. The margin is ot wavy, but uniformly convex. The surface very finely stippled.

2. That of the virulent variety ε, and the nonpathogenic γ, consists of a very thin idescent expansion having an irregularly wavy margin. The surface shows a few ranching radial furrows. This type of colony resembles closely that of the typhoid acillus.

3. The type of β and *B. typhi murium*, representing larger and coarser expansions ith wavy margin simulating closely the surface colonies of *B. coli communis*.

It will be observed that these varieties do not correspond to any special degrees of rulence. In general, however, it may be said that with one exception (γ) the igor of the surface growth is greatest with the least virulent varieties.

In bouillon the most virulent varieties (α, ε, η) and the abortion bacillus produce erely a moderate clouding. The less virulent varieties including the nonpatho-enic form γ produce a considerable turbidity.

The reaction depends entirely on the presence or absence of muscle glucose derived om the meat from which the bouillon is prepared. If this is present the reaction ecomes acid; if absent the reaction remains alkaline. The acid reaction becomes kaline after a variable length of time, provided the quantity of sugar in the ouillon does not exceed 0.5 per cent. This change is owing to a base produced uring the growth of the bacilli which slowly neutralizes the acid formed by the rmentation of the muscle glucose.*

On potato the growth is the same among the members of this group. There may e slight variations in the depth of color of the growth due to variations in the otatoes used. Now and then potatoes are encountered on which no growth appears. he surface assumes a glistening appearance but multiplication perceptible to the ye does not take place.

In milk no precipitation or coagulation of the casein occurs with any of the forms udied. There may be observed, however, if cultures remain in the thermostat at ast several weeks, a gradually developing opalescence of the milk. The milk ay even assume a light brownish appearance. During this prolonged stay in the ermostat the volume of the culture shrinks by evaporation and the opalescent uid becomes quite thick but not viscid. It is markedly alkaline. The addition of etic acid still causes precipitation of the casein. The process appears to be a kind saponification of the fat as a result of the increasing alkalinity of the culture ith age. This action of the hog-cholera bacillus was first noticed by Bunzl-edern † and subsequently observed independently by Dr. V. A. Moore ‡ in milk ltures of the nonmotile variety of *B. choleræ suis* η.

The fermentative characters of the members of this group are remarkably uniform. have tested them all in bouillon containing dextrose, saccharose, and lactose, respec-vely. Their behavior in the fermentative tube may be briefly defined as follows:

In peptone bouillon containing 1 per cent dextrose, gas appears within twenty-ur hours and continues to form for three or four days. During the first twenty-ur hours from one-third to one-half of the entire amount is formed, and at the end forty-eight hours fully five-sixths has collected. During the third and fourth y only insignificant amounts are formed. The gas formation thus begins promptly id subsides with equal promptness. The total quantity which collects in the osed branch of the fermentation tube is equivalent to nearly one-half the capacity this branch. The multiplication of the bacilli is rather feeble and subsides omptly. The strongly acid reaction developed during the fermentation is respon-ble for the cessation of growth and the subsequent destruction of the bacteria.

The gas set free is made up of carbonic dioxide and an explosive residue, probably ydrogen. The ratio of CO_2 to the latter is approximately as 1 to 2. This ratio

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*On the method of determining the presence or the absence of muscle glucose in ouillon see the Wilder Quarter Century book (1893), p. 197.

† Arch. f. Hygiene, XII (1891), p. 198.

‡ Bulletin No. 3, p. 53.

holds only for the tube used and is different when gases are not allowed to escape. The reaction of the fluid is strongly acid.

A table illustrating the formation of gas in dextrose bouillon is subjoined:

Bacilli belonging to the hog-cholera group cultivated at 98° F. in bouillon containing one-fourth per cent peptone, 2 per cent dextrose, and one-half per cent sodium chloride.*

Culture.	Quantity of gas at 98° F. set free after— One day.	Two days.	Three days.	Four days.	Five days.	Total 70°–80° F.	CO_2.	Explosive remainder (H).	Reaction.
	Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	
α									
Nebraska, 1889	17.4	41.7	54.8	60.0	57.4	54.8	38.0	62.0	Acid.
District of Columbia, 1889	24.0	48.0	54.4	56.0	54.4	50.4	30.0	70.0	Do.
β									
Nebraska, 1886	32.5	35.8	37.5	40.0	37.5	36.6	34.0	66.0	Do.
γ									
New Jersey, 1890	33.3	48.3	51.6	56.6	55.0	50.8	37.7	62.3	Do.
ϑ									
New Jersey, 1890	40.8	50.0	53.6	56.0	53.6	50.4	38.0	62.0	Do.
ε									
Virginia, 1890	34.7	51.3	55.6	58.2	57.4	53.9	37.0	63.0	Do.
ζ									
Maryland, 1889	43.4	48.6	50.4	52.1	50.4	46.9	37.0	63.0	Do.
Virginia, 1889	45.0	58.2	58.2	58.2	55.8	52.4	36.0	64.0	Do.
η									
Non-motile bacillus	....	....	....	33.0	37.5	36.6	26.0	74.0	Do.
Abortion in mare	12.1	50.0	58.2	61.7	59.1	54.7	36.5	63.5	Do.
Swine pest	32.8	43.4	45.0	45.0	45.0	41.8	33.3	66.6	Do.
Mouse typhus	....	46.4	48.0	....	50.0	50.0	35.0	65.0	Do.
B. enteriditis	....	48.8	52.0	....	48.8	48.8	29.5	70.5	Do.

* There is no noticeable difference between 1 and 2 per cent dextrose bouillon.

This table demonstrates the marked uniformity among the members of this group in their behavior towards dextrose bouillon. Bacillus β and η produce somewhat less than the normal quantity of gas. It should be borne in mind, however, that the culture of β was over six years old when this gas test was applied. As to η it is not so easy to explain the variation.

A further evidence of the close relationship of the members of this group is manifested in saccharose and lactose bouillon. If the bouillon is free from muscle glucose not a trace of gas appears and the reaction, as determined with litmus paper, remains unchanged, or becomes more strongly alkaline. This must be regarded as sufficient evidence that these sugars are not attacked. The absence of any power to ferment lactose thus differentiates this group sharply from the colon group, some of which act upon lactose and saccharose as well as dextrose, others upon lactose and dextrose only. In both groups the action on dextrose is the same.

In order to facilitate the comparison of a considerable number of cultures with reference to the formation of indol Kitasato's method was used. Tubes containing 10 cubic centimeters of a sterilized solution of 1 per cent peptone and 0.5 per cent common salt in distilled water were inoculated with the various members of the hog-cholera group, and placed at 37° C. for from one to three days. The growth in all tubes remained very feeble. The presence or absence of indol was determined by adding to each culture 1 cubic centimeter of a 0.02 per cent solution of potassium nitrite, freshly prepared, and about 3 small drops of concentrated, chemically-pure, sulphuric acid. As a guide a number of cultures of *B. coli communis* were treated in the same way. The color appeared slowly and was most distinct

ıfter sixteen to twenty hours. While the cultures of *B. coli* assumed a decidedly red ppearance, a few members of the hog-cholera group became feebly pink, the color f the culture of γ being the most accentuated. After a few days a decidedly carıine red deposit appeared in the cultures of *B. coli communis*. The deposit formed y the members of the hog-cholera group was whitish or feebly pinkish. This test hus gives for the colon group a different color than for the hog-cholera group. It oes not discriminate distinctly between members of the latter group and varies in ıtensity from almost complete absence of color to a decided violet pink, in cultures f γ, the nonvirulent variety.

In general cultures of hog-cholera bacilli are free from all odor. Among the more aprophytic varieties (γ, ζ) I have detected, in bouillon cultures contained in tubes ermitting but little interchange of air, a faint sour odor.

Pathogenesis.—There is considerable divergence in pathogenic power among the arieties of hog-cholera bacilli and the other members of this group. A comparison f the results obtained by inoculation into rabbits shows this very clearly. Thus Bac. α is invariably fatal in very small subcutaneous doses. The same is true of Bac. ε. Bac. β also was originally of nearly equal virulence. Bac. ζ was originally atal in some cases when rather large doses, 0.2 to 0.3 cc., of a bouillon culture were njected subcutaneously.

The rest of the group are fatal only when injected into an ear vein. For this end small quantity (0. 1 cc. or less of a bouillon culture) has been usually sufficient. has no more pathogenic power than *B. coli communis* under like conditions. The riginal virulence of *B. typhi murium*, *B. enteriditis* and the swine-pest bacillus had ındoubtedly been greatly reduced before they came into my hands. They were, owever, still fatal to rabbits in small intravenous doses.

Besides a divergence in the degree of pathogenic power as determined by the quantity of culture fluid required to destroy rabbits there is a divergence in the ıature of the pathological processes set up which is not wholly explained by a mere lifference of degree.

Thus bacillus ζ produces in rabbits suppurative changes in the lymphatic pparatus of the intestines and the mesenteric glands in contradistinction to the ıecrotic and hemorrhagic lesions of the more virulent α. If we attempt to explain his as a mere difference of degree we are confronted by the abortion bacillus which s much less virulent than ζ, but when injected into the circulation produced marked ıecrotic lesions, in this respect standing nearer α. There is no doubt that with a eduction of virulence the necrotic give way in part to the suppurative processes, out this is not wholly true and we must accept subtle varieties of virulence not asily described. A marked illustration of this is the production of a peculiar oseudo-tubercular affection of the peritoneum in rabbits by a virulent hog-cholera oacillus of the α type attenuated by being contaminated with *Proteus vulgaris*. * Simple loss of virulence through long cultivation on artificial media does not oroduce such a peculiar modification.

A number of rabbits which were examined several weeks to months after recovery rom a nonfatal dose of many of the bacteria described above showed in the appenlix vermiformis and more rarely in Peyer's patches at the ileo-cæcal valve a few infilrated follicles which appeared as whitish dots. This localization of the bacilli of his group in these follicles is perhaps the most constant macroscopic change to be redited to them. It appears only when the disease, after subcutaneous or intraveıous inoculation, has lasted longer than a week or ten days.

In the table below an attempt has been made to bring together the minor variations among the members of this group and to omit all common characters. This table naturally suffers from the defects inherent in all tables attempting to formulate subtle differences. This is particularly true of any estimate of pathogenic activity. For a more accurate conception of this the reader is referred to the autopsy notes on rabbits in this and former publications.

* See p. 88.

Variety or species.	Original source.	Morphology.	Motility.	Surface colonies on gelatine plates.	Bouillon cultures.	General character of growth.	Pathogenic power with reference to rabbits.	
							Degree as expressed in numbers.	Character.
B. choleræ suis α	Swine	Involution forms usually absent.	Active	Small, round, slightly convex.	Moderately clouded.	Only slightly vigorous.	1	Necrotic foci in liver.
B. choleræ suis β	Swine	Somewhat longer forms in bouillon membrane.	Active	Large; spreading like *B. coli.*	Surface membrane; growth turbid.	Vigorous; requires more alkali.	2	Necrotic foci in liver.
B. choleræ suis γ	Swine	Involution forms common; slightly larger than α.	Active	Small, delicate colonies, resembling *B. typhi abdominalis.*	Turbid	Vigorous	Very feeble.	Like *B. coli.*
B. choleræ suis δ	Swine	A trifle plumper than α.	Active	Like α	Turbid; bacilli in clumps in early cultures.	Fairly vigorous	4	Same as α.
B. choleræ suis ε	Swine	Like α	Active	Like γ	Like α	Fairly vigorous; agar growth viscid.	1	Same as α.
B. choleræ suis ζ	Swine	Slightly larger than α	Active	Like α, but larger	Turbid	Vigorous	3	No liver necrosis; suppurative changes in Peyer's patches, etc.
B. choleræ suis η	Swine	Like α	No motility	Same as α	Clouded	Like α	1	More speedily fatal than α.
Bacillus of abortion in mares.	Vagina of mare.	Like α	Motile	Same as α or nearly so.	Clouded	Like α	4	Necrosis in liver and spleen.
Swine pest	(Denmark)	Like α	Motile	Same as α or nearly so.	Clouded	Like α		Same as α.
B. typhi murium Læffler.	White mice (1890).	Plumper than α	Motile	Spreading like β	Turbid	Vigorous	4	No necrosis in liver.
B. enteriditis Gærtner.	Cow	Rather slender forms; variable.	Motile	Like α	Turbid	Vigorous	4	No necrosis in liver.

If we attempt to sum up those characters which are to circumscribe the hog-cholera group of bacteria we are at once confronted by the scarcity of common characters, as shown in the table above. Pathogenesis, though of great importance from the standpoint of pathology, is probably the last character acquired and evidently the most variable and most readily lost. If we base the unity of this group on morphological and biological characters, we are likewise met by variations in size, absence of motility, variations in the appearance of the colonies. There are, however, certain underlying characters, as expressed by the behavior of these bacteria in bouillon containing dextrose, saccharose, and lactose, which I think will serve as a very important group character, differentiating such group sharply from the colon group. I would therefore suggest that for the present all bacteria whose size approximates that of this group, which do not liquefy gelatin and whose fermentative properties are the same as those described for this group, should be ranged under it. Future investigations into the biochemical characters of these varieties or subspecies may reveal other differential characters, but the time has not yet come when such laborious work will be undertaken on a sufficiently extensive scale to be of any service in differentiating varieties and subspecies.

A question of considerable importance to which I wish to refer very briefly in conclusion is the origin of these varieties. Are, for instance, all the varieties of hog-cholera bacilli derived from one virulent form, or have they adapted themselves from a diversity of originally related saprophytic forms, such as the colon bacilli living under the similar conditions on mucous membranes, to a parasitic existence in the organs of the living animal?

Neither view is negatived by the information thus far at hand, but the second seems the more probable to the writer. A thorough discussion of this problem, so important to epizoötology, is premature, and it is simply suggested to call attention to its important bearings.

TWO OUTBREAKS OF SWINE DISEASE CAUSED BY BACILLUS CHOLERÆ SUIS ? ASSOCIATED WITH THE SWINE-PLAGUE BACILLUS.

The following investigations, made four years ago, are now published for the first time. Their interest centers in the fact that in both outbreaks a much less virulent variety of the hog-cholera bacillus than that usually met with was found. The disease was likewise different from the ordinary acute hog cholera in several respects. It will be noticed that in nearly all cases swine-plague bacteria were present in the diseased lungs and in the intestines. Both outbreaks are thus illustrations of a mixed infection. In these investigations the information concerning the outbreaks was gathered by Dr. Kilborne, and the writer is indebted to him for the care of the animals at the Experiment Station and the notes made during the course of the disease. The writer is responsible for the pathological and bacteriological work.

I.

The history of this outbreak, as given by the owner, points very clearly to the importation of the disease from without.

On December 15, 1888, Mr. P., living near Knowles, Md., had eight fine shoats about 3 months old, and on this day he purchased a cheap lot of pigs in the Washington markets. One of these died on the way home, two others died during the two following days, and within ten days seven had died. The last one of the new lot died, greatly emaciated, January 20, after a sickness of from three to four weeks. The original lot on the farm showed signs of disease early in January, and up to January 22 four had died. Of the remaining four two are quite sick and two apparently well. Among the symptoms noticed by the owner was a rapid falling away in flesh, while the appetite remained fairly good up to the time of death. There was a severe cough, coupled with a nasal discharge and considerable diarrhea. In the latter stages of the disease the skin of the limbs, belly, and ears became deeply reddened. The ears turned almost black and "lopped, like the ears of a dog." On the limbs and belly the skin became "scabby, like a person with smallpox."

January 22. One of the original lot (No. 1) which died last evening was examined on the place. It was very much emaciated, the skin of ears, limbs, and abdomen a deep purple, shading into black. On the limbs numerous purplish crusts or scabs, one-sixteenth to one-eighth inch in diameter. The spleen somewhat congested, the liver pale; interlobular connective tissue increased in quantity; when cut a sensation of grittiness is imparted to the hand. The kidneys are pale, the surface with a few petechiæ. Lymphatic glands (with exceptions to be mentioned) in general slightly enlarged, with cortex dark colored. The lungs, stomach, and intestines were taken to the laboratory for a more careful examination.

Both lungs, with the exception of the caudal four-fifths of the principal lobes, solid, and moderately larger than the collapsed normal lung would be. The hepatization appears to be a cellular (catarrhal) plugging of the smaller bronchi and alveoli manifesting itself by a uniform mottling of the lung surface with yellowish dots. The extent of this catarrhal filling up is shown by the greater or smaller size of the yellowish dots, which in the cephalic lobes in part coalesce, so as to give the lung tissue a uniformly yellowish-gray appearance. The entire solid portion feels granular and hard. Imbedded in the normal tissue of the right principal lobe is a mass of solid tissue, as large as a hen's egg, in a more advanced state of degeneration. On section a number of sharply but irregularly outlined masses of a pale grayish-yellow appearance, evidently necrotic, make their appearance. In the left principal lobe are two small solid masses one-half inch in diameter. The pleura is not inflamed excepting over the solid mass in the right principal lobe. Here it is one-sixteenth inch thick, opaque, roughened, and wrinkled. On opening the air tubes the smaller bronchi are found very much dilated by thick purulent contents. When the latter is removed cavities appear from the size of a hemp seed to that of a bean, which are due to distention (bronchiectasis). The larger bronchi and the trachea contain a considerable amount of a dirty, muco-purulent, partly foamy liquid, through which are disseminated small whitish flakes. The mucosa is dusky, its minute vessels injected. In the caudal portion of the large bronchi and adjoining branches, numerous lung worms. Cover-glass preparations from the lung tissue show immense numbers of bacteria of several kinds.

The stomach is slightly pigmented in the fundus, and here two small superficial ulcers are found. Beyond the region of the fundus the mucosa is beset with minute papules about one-sixteenth inch across, somewhat paler than the surrounding mucosa. The small intestine is apparently intact, excepting the Peyer's patch in the ileum near the valve, which is swollen, pigmented, and has its surface pitted so as to give it a finely honeycombed appearance.

The mucosa of the large intestine is in general very much pigmented and hence quite dark in color. Throughout caecum and colon it is studded with sloughs from one-sixteenth to three-sixteenths inch in diameter, there being from five to ten to a square inch of surface. They are round, slightly projecting, convex. The projecting mass is of a dirty yellowish color and easily scraped away, as a pulpy or friable mass, exposing either a slightly raised or depressed rough surface almost white compared with the surrounding tissue. This firm mass extends only to submucosa. The mesenteric glands are slightly enlarged, bluish red; on section a reddened line can be seen under the capsule surrounding the gland tissue.

On the ventral surface of the kidneys were about fifty dark bluish spots (ecchymoses). On section the cortex pale, the medulla darkened, the minute vessels of the mucosa in the pelvis injected.

Sections of a slough from the large intestine, hardened in alcohol, examined subsequently under the microscope, showed that that portion of the tissue included in the slough failed to retain the stain. It involved the mucous crypts down to the submucous tissue. These were necrosed, although their original outline could still be faintly seen. Adhering to the surface of these and projecting slightly above the neighboring living tissue was a layer of exudate, consisting of amorphous matter not stainable. Beneath the layer of crypts the submucosa was more or less thickened by cell infiltration; the muscular coat intact.

Bacteriological examination.—From the spleen of this pig four cultures on agar were made, and in all a large number of isolated colonies appeared on the following day. These resembled hog-cholera bacilli colonies very closely. They were from one to three millimeters in diameter, according as they were crowded or scattered; pale grayish in color. In form and motility the bacilli could not be differentiated from hog-cholera bacilli. Subsequent observations showed slight difference, however, in the mode of growth in various media. That they were slightly different from bacillus α was shown by the following experiment:

January 29. From a bouillon peptone culture of this bacillus one-eighth cubic centimeter was injected subcutaneously into a rabbit. During the following three days the temperature rose 4° F. and then gradually fell to normal on the tenth day. It was killed on the fifteenth day, when fully recovered, and an abscess found in the groin extending to the abdomen and thigh and containing a rather consistent yellowish-white pus. The internal organs, including peritoneal cavity, appeared normal. Four bouillon peptone tubes were inoculated from the spleen and liver, as follows: Two received each nearly one-half of the entire spleen of the rabbit and two equally large pieces of liver tissue. One spleen and one liver culture became clouded after several days and contained the motile bacillus originally injected into the rabbit, and this only. Two remaining tubes were sterile weeks later.

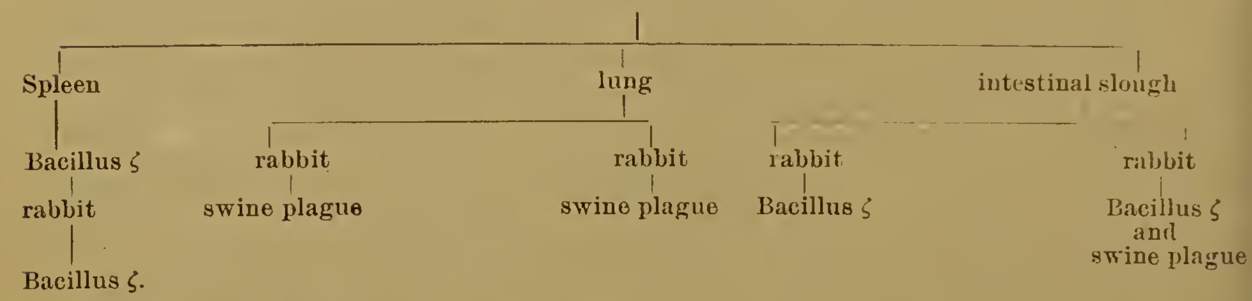
January 23. A bit of lung tissue in which the disease process appeared most recent was torn up in sterile bouillon and one-fourth cubic centimeter injected under the skin of a rabbit. Cover-glass preparations show immense numbers of bacteria of several different forms. The rabbit was found dead January 28. There was considerable suppurative thickening of the subcutis and fascia on the inoculated thigh with some ecchymosis. In the abdominal cavity a slight amount of stringy exudate on the coils of intestines and some ecchymosis on the caecum. In the blood, spleen, liver, and peritoneal exudate numerous cocci, some of which show a polar stain. Agar cultures from peritoneal exudate and blood were placed at 37° C. The blood culture on the following day contained only swine-plague bacteria, the peritoneal culture other forms also.

At the same time another rabbit was inoculated in the same way with lung tissue which was in a more advanced stage of degeneration. This rabbit died January 28. There was an extensive pasty thickening of the subcutis on both aspects of the inoculated thigh, although there was no accompanying peritonitis. From the blood a pure agar culture of swine-plague bacteria was obtained.

A piece of the ulcerated large intestine had been kept in a sterile bottle on ice since the autopsy. On January 25 a rabbit was inoculated subcutaneously by injecting one-fourth cubic centimeter of a suspension of the ulcerated tissue torn up in sterile water. This rabbit died in four days with extensive subcutaneous pasty infiltration over the inoculated thigh, and peritonitis manifested by punctiform ecchymoses under the serosa of cæcum, membranous exudate on the peritoneal covering of spleen, liver, and cæcum. These lesions are characteristic of swine plague. An agar culture from the blood developed an abundant pure growth of swine-plague bacteria, while a culture from the abdominal exudate contained both the swine-plague bacteria and hog-cholera bacilli.

On January 26 a second rabbit was inoculated in the same manner from another bit of ulcerated mucosa. It was found dead on the eighth day. The subcutis of thigh, abdomen, and thorax were very much thickened with a pasty grayish yellow infiltration and extensively discolored by blood extravasation. Peritonitis slight, perhaps caused by the very many cysts of a cysticercus attached to the omentum. Spleen but slightly enlarged. From the blood two cultures, an agar and a bouillon culture, were prepared. In both only the motile cholera bacilli appeared. The results may be tabulated as follows:

Pig No. 1.



The two pigs from this herd which were diseased were taken to the Experiment Station January 22, and placed in carefully disinfected pens. One of these died on the following day.

Autopsy.—No. 2. White male, weighing about 60 pounds, in fairly good condition. A bright scarlet blush extending along both sides of the body as a band, 3-4 inches wide, and continued on the hind limbs nearly to the feet; the same blush on both ears and under surface of jaw and neck. Along the median line on the belly there is a strip purplish in color. The urinary meatus is stained by a subcutaneous hemorrhage. On the ventral aspect of the neck are 5 to 6 scabs one-fourth inch in diameter. These adhere very firmly, and covered by them are red, depressed spots, representing the true skin.

Superficial pubic glands about 2 inches long; lobules, pale red; very œdematous, the serum amber-colored as it flows from the cut surface. On opening abdomen, a large clot was found attached to the ventral abdominal wall near the spleen, and extending down between the coils of the small intestine; spleen very large, soft, dark. It is about 14 inches long, 3 inches wide, and three-fourths inch thick. The origin of the hemorrhage could not be traced. It may have come from the enlarged, congested spleen during the journey.

The stomach filled with food; mucosa normal; the small intestine normal. In the cæcum there are four neoplastic growths, one of them on the valve. There are six more in the upper 8 inches of the colon. The remainder of the large intestine has a normal mucosa, and is filled with lumps of hard, dry feces. The neoplasms, situated on a pale otherwise intact mucosa, are worthy of some attention. They are about three-fourths inch in diameter. Some project one-half inch above the mucosa, others are flatter, resembling a low, broad-rimmed hat. Cutting vertically through one of the projecting masses, we have first, a thin, coal-black surface layer, beneath

ıis is a firm, pale yellow, almost leathery tissue, which forms the bulk of the pro-cting mass. The muscular coats beneath this are fused together, the neoplasm ·ojecting somewhat deeper into them in the center than on the periphery. Lastly, ıe serous membrane under these masses thickened, discolored by old extravasa-ons, and in some places adherent to adjacent structures.

The lungs are extensively diseased. Of the right lung the caudal tip and cephalic ›rder of principal lobe, the ventral half of ventral and cephalic lobe are solid, and the same condition as the lungs of pig No. 1. The surface mottling is faintly ırked, owing to the pale, œdematous appearance of the diseased tissue. On the ıphragmatic surface of the principal lobe several areas of pneumonia are visible. ' the left lung the principal lobe contains a number of infiltrated lobules, the ven-ıl lobe is entirely hepatized, its tip of a uniform grayish opaque color; the cephalic bes contain a number of scattered hepatized lobules.

Trachea and bronchi almost occluded with molds of a pale yellow opaque muco-ıs. The terminal portion of both bronchi contain masses of lung worms.

In three agar tubes, inoculated by dropping into them bits of spleen tissue, no owth appeared. A rabbit inoculated with one-fourth cubic centimeter of a sus-nsion of diseased lung tissue remained well.

The second diseased pig (No. 3), brought to the station January 22, was found ıad on the morning of January 30. The lesions were limited to the lungs and :ge intestine, as the following notes show:

No. 3. Medium sized female, white. Decided reddening of skin over the pubic gion. Of the right lung the cephalic and ventral lobe solid, granular to the touch. om the surface the lung tissue appears closely set with pale-yellow, minute spots. ese give the tissue its granular consistency, and probably correspond to plugged d distended air vesicles. When a section is made through this solid tissue white nsistent masses can be forced out of the air tubes, which are greatly enlarged in ne places. In the cephalic lobe emphysematous lobules are interspersed in the id tissue. In the principal lobe several foci of a grayish hepatization are present, ıile about one-half of the azygos lobe is solid.

Of the left lung the dependent half of the cephalic and the ventral lobe and about e-sixth of the principal lobe are hepatized. In the latter the disease is scattered lobules having their bases chiefly in the diaphragmatic surface of the lobe.

Trachea and bronchi in part occluded with a very viscid, opaque, whitish muco-s mixed with foam, and containing fragments of lung worms.

Both sides of the heart contain large clots, dark in the center, pale outside where ›y touch endocardium, with branches extending into the large vessels.

Kidneys very pale. Liver gritty to the knife. The parenchyma softer than nor-l. Lymphatic glands in general swollen and slightly reddened.

The disease in the digestive tract is confined to the large intestine. The ileo-cæ-valve has its mucosa completely replaced by a layer of a homogeneous, cheese-e, rather firm material, whitish, the surface stained yellow. In the cæcum and :ceeding 8 inches of colon are 8 roundish sloughs from one-fourth to one inch in meter, of the same nature. Lower down in the colon are ulcers from one-eighth one-fourth inch in diameter, about 6 to a square inch. Many of these are ıde up of an elevation or tumefaction of the mucosa about the size of a split ı, in the center of which is a depression filled with yellowish matter. Subsequent croscopic examination of these ulcers hardened in alcohol showed that they rep-ented the solitary lymph follicles, swollen and ulcerated. Near the valve the ge Peyer's patch presented the same appearance of ulcerated follicles in sections. e mucosa was everywhere of a dark, bluish-red color.

Bacteriological examination of the diseased lung tissue showed that the cheesy sses plugging the air tubes, which seemed to be made up exclusively of pus cor-scles, contained a large number of bacteria of different forms. A rabbit inocu-ed from some of the lung tissue torn up and suspended in sterile water did not come ill.

A rabbit which received an injection of a suspension, in sterile water, of a small portion of ulcerated tissue from the large intestine, died in three days from swine plague. At the place of inoculation the infiltration was slight. In the abdomen slight fibrinous exudation, hemorrhages under serosa of cæcum and rectum. Spleen congested. In the abdominal exudate, in the spleen and blood numerous bacteria, showing the polar strain well in cover-glass preparations from the blood. Agar cultures from spleen and blood contain an active vegetation of this germ on the following day.

The spleen of this pig, scarcely enlarged, showed no germs on cover-glass preparations. But three agar and one bouillon-peptone culture, made by adding bits of spleen tissue contained each on the following day an active growth of bacillus ζ. In two agar tubes the colonies were isolated in the upper part of the inclined layer, and from these cultures were made into other tubes.

From one of these second bouillon-peptone cultures a rabbit received into the thigh subcutaneously one-eighth cubic centimeter, February 1. The temperature of this rabbit on the following day was 104.2; on the 4th to the 8th, inclusive, it was 105.7, 106.8, 106.8, 104.5, and 102.6, respectively. The rabbit was killed two weeks after inoculation when evidently in good health. An abcess was found in the groin filled with partly curdy, partly putty-like pus. About one-third of the spleen dropped into each of the two bouillon peptone tubes. After several days both became clouded and contained only the motile bacillus injected into the rabbit. The following table summarizes the results:

Pig No. 3.

lung	spleen	intestinal slough
rabbit	Bacillus ζ	rabbit
(negative)		swine-plague bacteria

January 22. No. 121. A pig about three and one-half months old was placed in the pen with the preceding cases. One of these, it should be borne in mind, died January 23, the other January 30. Hence this animal came in contact with diseased animals as well as an infected pen. No. 121 was very much emaciated after three weeks' exposure; its respiration was labored and accompanied by a groan; its back arched, flanks drawn in. The emaciation and weakness grew, and it died February 17, nearly one month after exposure. In the meantime several other fresh pigs had been added, and these attacked the carcass during the night and consumed part of the left lung and the heart. The autopsy made next morning revealed the following lesions:

Several hemorrhagic spots on abdomen; superficial sloughing of skin in patches on the sides of the thorax and abdomen. Also a number of scabs or crusts from one-eighth to one-quarter inch in diameter in the same situation, similar to those found on the other pigs. The spleen is barely changed in size and consistency. The lymphatics in abdomen small, slightly reddened, and pigmented. The serosa of large intestine of a more opaque white in patches and diffusely stained indicative of disease within the tube. Kidneys and liver apparently normal.

In the stomach the pyloric half of the mucosa of greater curvature is quite deeply congested. The small intestine is normal, the large intestine very severely diseased, however. Contents have the color and consistency of pea soup. The mucous layer of the entire cæcum and valve, with the exception of a small area in the blind end, is converted into a tough, yellowish-white, homogeneous layer, the free surface of which is very irregular. Its appearance might be compared to the roughness produced by cork lining, or by sprinkling small irregular fragments thickly over surface. The entire thickness of the changed mucosa is about one-eighth inch

·nly bound to the muscular coat which appears as a dark red œdematous layer on ction. The serosa is thickened and discolored.

Below the cæcum the necrosis breaks up into roundish ulcers gradually thinning t. There are about three to four to a square inch for the first 18 inches below ·o-cæcal valve. These ulcers are roundish, with a central plug of amorphous fria- e, orange-colored substance, very rough on the surface, surrounded by a border of paler-yellow necrotic material. When the slough or exudate (whatever it may ve been at the start) is scraped away, a white patch appears which represents the lammatory infiltrate, partly necrosed, partly neoplastic, extending to the muscu- · coats. The greater part of the mucosa not destroyed by these sloughs is covered thin, yellowish patches, not easily scraped away. When this is attempted the ·mbrane beneath is pale and roughened. What remains of the membrane not cov- ·d by ulcerations and exudate is of a dark slate color.

The remaining 2 feet of colon has its mucosa entirely covered by a yellow, leath- ·, rather smooth diphtheritic membrane about one-sixteenth inch thick. When ·aped away the membrane still adheres. The muscular coats are thickened, œde- ıtous and redder than normal on section. The meso-colic glands are enlarged, the rtex pigmented.

The lungs are the seat of broncho-pneumonia. As already stated, the left ventral d cephalic lobe had been eaten by pigs in the same pen. The remaining principal ɔe is œdematous, somewhat hypostatic. The dependent or free half of the right ıtral and all of the cephalic lobe is solid, barely larger than in the collapsed rmal condition. The pneumonia is identical with that found in the preceding ses, i. e., catarrhal plugging of air tubes, distention of alveoli by cell exudates, d hardening of the same, the peculiar surface-mottling with small, yellowish dots, ıng the result. The tip of the ventral lobe is covered with a thin sheet of gray- ·, fibrinous exudate. The cut ends of the small air tubes exude on pressure cylin- cal curdy plugs, some of these showing on their surface the impress of the minute ıgitudinal folds of the mucous membrane. Through these two lobes are also dis- ninated about 12 necrotic foci, from one-eighth to one-half inch in diameter, con- ting of greenish-gray homogeneous, rather firm caseous masses. The right prin- ·al lobe œdematous. The bronchi appear normal except in the diseased lobes. re the membrane is bluish and, on pressure, the mouths of the branches exude a ck, yellowish fluid.

Microscopic examination.—Sections of the mucosa of the large intestine overlaid by e uniform pale-yellowish diphtheritic layer showed some very interesting char- ·ers. On the mucosa was an amorphous layer which failed to retain the stain kaline methylene blue) excepting along the free border where a line of blue was olved into masses of saprophytic bacteria growing on the surface of the dead sue. This exudative layer, about one-eighth millimeter thick, rested upon the cosa proper, deprived of its epithelium, and at certain places the process of struction had invaded the membrane as far as the fundus of the tubules, of which ; outlines could barely be distinguished and which remained unstained. The sub- cous layer was considerably thickened by the infiltration of large numbers of ıcocytes.

Careful examination under a high power showed that wherever the destructive ·cess dipped down into the membrane itself, and in a section one-half inch long, s occurred five to six times; there a definite bacillus could be found. This bacil- pervaded the necrotic area and extended to the submucosa in large numbers. ıerever only the fundus of the tubules was intact, it was completely filled up by se bacilli forming large clumps of long, intertwining filaments. They were the ly germs seen to extend into the normal tissue. Although appearing as long fila- nts, closer inspection revealed shorter forms, usually in pairs, each of which ıtained a paler central portion. The measurement of these long filaments diving

in and out of the tissue, and their resolution into segments was quite difficult. The short forms measured about 1.2 to 1.5 μ in length, and 0.5 to 0.6 μ in width.

Sections prepared from the deep circular sloughs show an unstainable necrotic mass extending almost to the muscular layers in the center and growing more and more shallow towards the periphery of the ulcer. Underlying the necrotic mass and extending a short distance from the slough is a zone of densely packed leucocytes causing a great thickening of the submucous tissue. In this ulcer neither the deeper layers of the slough nor the surrounding inflammatory zone contained bacteria.

Bacteriological examination.—From the spleen cultures on agar, in bouillon peptone, and in Esmarch tubes (gelatin) were made. In all the motile cholera bacillus ζ appeared, and in the bouillon tube also a streptococcus. The former must have been quite numerous in the spleen tissue, judging from the number of colonies in the roll cultures.

In order to test its pathogenic nature, a rabbit was inoculated February 20 by rubbing with a platinum loop some agar growth of this germ into the subcutis of abdomen. On the seventh day the temperature had risen to 105°, then it slowly fell back, reaching the normal on the fourteenth day. An abscess was forming meanwhile, which broke on the eighth day while taking the rabbit's temperature, and discharged pus freely. The rabbit was killed on the fifteenth day. Besides the abscess already noted, there was some enlargement of the spleen, but no germs were found in it on microscopic examination. The inoculated germ was still present in the spleen, however, for two bouillon peptone tubes, into each of which about one-third of the spleen was dropped, became clouded in forty-eight hours, with this and none other germ.

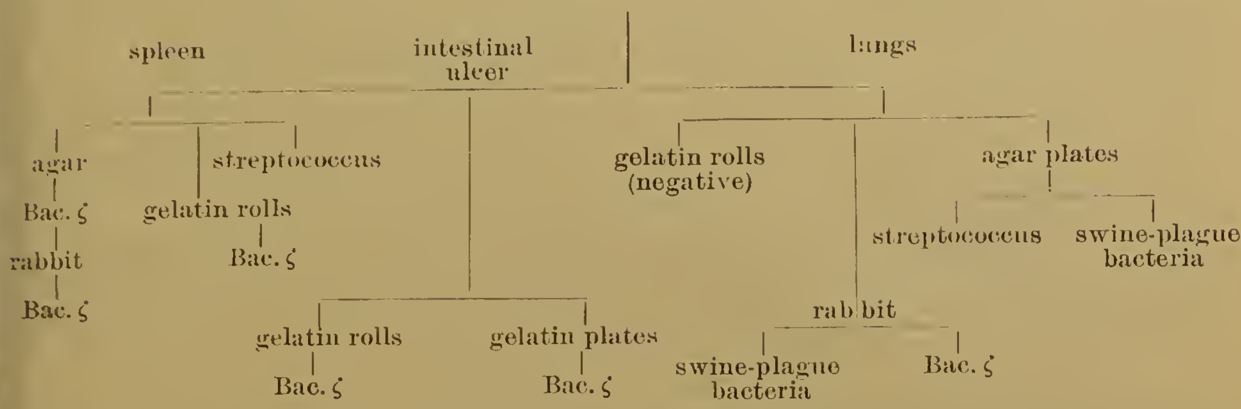
From a bit of diseased lung tissue four roll cultures are made in gelatin. The lung tissue had shown many bacteria not of one kind under the microscope. The first became completely liquefied; the others contained but a few colonies. One of these represents a micrococcus, another a slender motile bacillus. At the same time agar plates were made from the lung tissue. From these were isolated a large coccus, a streptococcus, and swine-plague bacteria.

At the same time a bit of diseased lung tissue was placed beneath the skin of a rabbit on the abdomen. It died in four days. There was extensive suppurative thickening and sanguinolent infiltration of subcutis of abdomen. Slight adhesion of cæcum to abdominal wall, with ecchymoses. Spleen small. In blood a few polar-stained bacteria found. In subcutis they were also seen amongst other forms. From culture of the blood and spleen several germs were obtained; one resembling swine plague, a second the hog-cholera bacillus, and a third nonmotile oval microbe. In order to identify the swine-plague germ in one of the impure agar tubes from the blood, a little of the swine-plague growth was placed under the skin of a second rabbit. Its temperature rose to 106.6° F. on the third day. On the seventh day it had fallen to 99.2° and it was found dead next morning. The lesions were those of swine plague. There was the local subcutaneous infiltration, whitish, pasty. The inoculation over the lowest ribs had caused extensive exudative pleuritis and pericarditis, the exudate being of a creamy consistency, covering the greater part of the lung tissue of right side, less extensive on left (inoculated) side. On the epicardium a similar deposit. Agar and bouillon peptone cultures from the spleen, blood, and pleural exudate made. All but that from the spleen fertile with swine-plague bacteria.

From the diphtheritic mucosa of the large intestine of the pig gelatin roll and plate cultures were made. That portion of the mucosa most recently diseased was taken, thoroughly washed by pouring sterile water over it and material from the scraped membrane taken. Of the gelatin roll cultures one became entirely the other partially liquefied. But there were a sufficient number of nonliquefying colonies intact to make cultures in different media. When developed they all contained the hog-cholera bacilli. On the plates there were very many nonliquefying among

a few liquefying colonies. Subsequent examination with the microscope and in cultures showed that they represented hog-cholera bacteria. The following table summarizes the bacteriological examination:

Pig No. 121.



Two fresh pigs (Nos. 126 and 128) about four months old, in excellent condition, were placed in the same pen February 12, to keep up the disease for further study.

No. 128 became emaciated within a week after the transfer and continued to grow feebler until March 5, when it was found dead. There were no distinctive symptoms excepting the wasting away.

Unfortunately the lungs had been entirely eaten out during the night by the other pigs in the pen, so that we have no knowledge of their condition. The spleen was but slightly swollen. In the liver there was stasis of bile in the larger ducts owing to plugging with ascarides which had forced their way up into the liver for some distance. The kidneys apparently normal.

The stomach is normal and filled with food; duodenum and jejunum, slightly congested, contain much yellow liquid. The mucosa of lower ileum, however, is very much reddened, and the smallest vessels visible to the naked eye distinctly injected. The gross lesions of the disease are limited to the large intestine. The mucosa is in a condition identical with that of No. 121. The entire cæcum involved. On section the mucosa is seen to be replaced by a dry, caseous, yellowish-white homogeneous layer, one-sixteenth inch thick, firmly bound to muscular coat. The free surface is very rough, yellowish, resembling the cork lining already mentioned. Below the ileo-cæcal valve about one-half of the membrane is involved, the caseous layer appearing in islands which are one-half to three-fourths inch square, easily scraped away as amorphous crumbling matter and leaving a decided depression. In the lower colon the deposit is less extensive and leaves scarcely any depression when scraped away. The mucosa where still intact presents here and there groups of petechiæ.

Bacteriological examination.—From the spleen of this pig cover-glass preparations were made, but the germs present were too few to be detected this way. Cultures on agar and in bouillon peptone from bits of spleen tissue contained next day bacillus ζ. To make sure, roll cultures in gelatin were made, and a rabbit inoculated from a culture derived from a colony. The illness of the rabbit was very slight. The temperature rose only to 103.8° F. on the third day, subsiding to 102.5° F. on the seventh. A small abscess had formed at the point of inoculation.

During the autopsy on the pig the bladder was ligated and removed with contents. For want of time it was kept on the ice for two days. Then the coats were burned through with a platinum spatula, several drops of clear urine added to gelatin and a roll culture made. After several days about 25 nonliquefying and several liquefying colonies appeared, the former made up of hog-cholera bacilli. Of the urine only about 10 cc. was found in the bladder. This was clear, pale-yellowish, acid, and containing much albumen. The deposit, after twenty-four hours, slight, somewhat viscid, consisting mainly of bladder epithelium.

No. 126, after being placed in the infected pen with No. 128, was found dead on the

morning of March 6, i. e., in twenty-two days. The course of the disease was precisely the same as with No. 128.

Autopsy notes.—Small black female. Behind right shoulder the skin was destroyed over an area of 3 to 4 square inches, exposing the subcutis. On the skin over the right pectoral muscle a cluster of scabs about 1 inch square. The lungs are but slightly affected. A small portion of the free end of right cephalic lobe collapsed, bluish red. A small area of collapse in right ventral, another in right principal lobe.

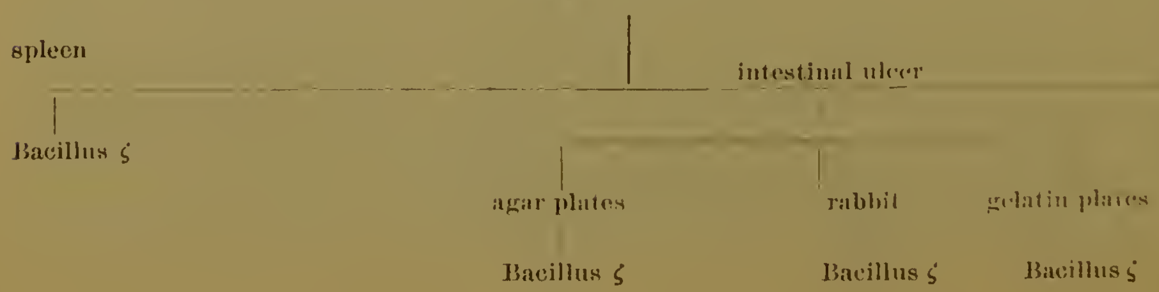
The lesions of the digestive tract closely resemble those of No. 128. The fundus of the stomach is considerably reddened. The duodenum contains several ascarides, one extending up the bile duct into the liver. The lower ileum considerably inflamed. The large intestine is extensively diseased. The mucosa is destroyed by a process identical to that observed in No. 128. Yellowish-white caseous transformation in large patches and bands in the cæcum and on the valve. Lower down in the colon exudative lesions still fresh; necrotic change of mucosa very slight. The rectum is involved as far as the anus in the same way.

Sections of the large intestine of pig No. 126 hardened in alcohol show about one-half of mucosa destroyed. Along a line half way between the base and the mouths of crypts is a densely stained line; beyond this only unstained amorphous débris attached to it, with free surface irregularly festooned. The same bacilli observed in sections of No. 121 are found dipping down in masses into the still living tissue, and wherever this dipping down occurs the tissue appears to be undergoing necrosis.

Bacteriological notes.—From the spleen of this pig the same hog-cholera bacillus was obtained pure in agar and bouillon peptone cultures, although too scarce to be detected on cover-glass preparations of spleen pulp. Its identity with the germs found in previous spleens was confirmed by its growth in gelatin roll cultures and inoculation into a rabbit. The temperature of the latter rose to 105.6° F. on the third day, but returned to 102° F. on the seventh day.

Agar plate cultures were made from a small bit of diseased intestine which was obtained as nearly as possible from the depths of the diseased membrane. From the plates the same motile germ was obtained, besides some liquefying forms. Plate cultures of gelatin were made at the same time. On these only a few liquefying colonies appeared. Of the others there were two forms, one growing on the surface as a very thin, spreading film, probably *Bac. coli communis;* the other appearing a day later and growing less vigorously, though by far the most numerous. This latter proved to be the hog-cholera bacillus. The presence of this germ was also demonstrated by the inoculation of two rabbits. A bit of the ulcerated intestine was placed beneath the skin of the thorax of each rabbit March 6. One died on the morning of March 12. The subcutaneous tissue of the whole abdomen and thorax was thickened and stained with blood, the skin was thickened and its under surface suffused with blood. The spleen slightly enlarged and congested. No peritonitis. The motile bacillus was seen in moderate numbers in cover-glass preparations and obtained in an agar culture from the spleen and the blood, about 25 to 50 colonies in each tube. A gelatine roll culture from the spleen contained a large number of one kind of colonies which were made up of the same germs. The second rabbit died next day, March 13. The lesions of the subcutaneous tissue were the same. The spleen was enlarged, dark, friable. Very slight ecchymosis and a few threads of fibrin on the cæcum. From agar and gelatin roll cultures of spleen and blood the same germ was obtained, but mixed with liquefying forms.

Pig No. 126.



II.

During September of 1889 Dr. Kilborne was directed to examine eported outbreaks of swine disease in Clarke County, Va. The dis-ase seems to have been lingering along the river below Berryville ince the previous winter, and had become especially virulent during ugust. It was estimated that about 75 per cent of the swine in the icinity of Berryville succumbed to the disease. At the time of the ispector's arrival there were very few sick, many having died during he two or three weeks preceding. The symptoms observed by the wners of herds were frequent coughing, diarrhea, and occasional vomit-ig. The affected animals lost flesh and strength very rapidly and ffections of the skin were not uncommon. Pieces were said to drop ff, leaving raw, deep sores. The skin of the ears and belly became urplish and was covered with sores.

Two pigs were killed by the inspector at the time which seemed dis-ased. The lesions in both were confined, as far as could be deter-ined at the time, to a broncho-pneumonia, involving in one pig nearly ne-half of the lung tissue. The lungs and spleens of both animals were rought to the laboratory. Culture from the spleen of one in bouillon eptone and on agar remained clear, nor could any bacteria be detected y microscopic examination of the spleen pulp. Cultures from the leen of the second pig developed into a pure growth of a large bacil-s with terminal spore which suggested malignant œdema. Two uinea-pigs inoculated from the culture remained well.

From the lungs of these two cases bits of diseased tissue placed under e skin of two rabbits without any result. On gelatin plate cultures om them only a few miscellaneous, liquefying colonies appeared.

Two diseased pigs were sent to the Bureau Station, so that more curate observations could be made on the nature of the disease and s communicability to healthy pigs. These observations finally showed at the disease was caused by a hog-cholera bacillus identical with cillus ζ, and that whatever the communicable power of the disease d been it was very feeble, for a pig penned with the two cases of sease passed through a mild disease only. The post-mortem notes, cteriological observations, and inoculation experiments which led to ese inferences are as follows:

Pig No. 3, received September 4, 1889, and placed in disinfected, isolated pen. imal at this time very thin and weak. Has been sick for a week according to itement of former owner.

September 6. Failing rapidly; diarrhea; passages dark, liquid.

September 7. Animal unable to rise.

September 11. Found dead this morning, and examined at once.

Autopsy notes.—Small female; very much emaciated. Over the sternal region the idermis peels off in large patches. One ulcer, concave, one-fourth inch in diam-r on the mucous surface of right side of upper lip, covered by a thin yellowish ite slough; another smaller one on left side. On the tongue 3 similar ulcers, one top and two on right and left border.

The mucosa of the fundus of stomach is intensely hyperæmic. The pyloric portion and upper duodenum deeply bile-stained. The entire length of the ileum is beset with depressed ulcers, of ragged, irregular outline, lined with a thin slough stained yellow. These ulcers are most numerous in the uppermost and lowest portion of the ileum. In cæcum and upper foot of colon there are many small ulcers. They are present on the valve as well as on the Peyer's patch near it. In the lower colon they are few but large, often one-half inch in diameter. They are found in the rectum in small numbers.

Liver apparently normal. Bile in bladder thick, full of flaky material and containing several firm lumps of a dark brownish color. Kidneys with cortex pale, dull on section. The urine in bladder contains many short, finely granular casts, and a slight amount of albumen. The spleen is but slightly enlarged.

Lungs.—Both ventral and cephalic lobes, three-fourths of median lobe, one-half of right principal lobe, and a number of scattered foci of left principal lobe, hepatized. The color varies from a bright red to a pale red, mottled with faint yellowish dots. The hepatization is firm, granular to the touch. In trachea and bronchi abundant viscid muco-pus. Bronchial glands moderately enlarged, firm, of a pale pink color. Cover-glass preparations, from what appear to be the most recent diseased regions, show a large number of bacteria, resembling those of swine plague, within the protoplasm of the cells forming the exudate into the alveoli and minute air tubes.

The lymphatic glands near the stomach, in the angle of the lower jaw, those of the inguinal region beneath the skin, and under peritoneum near kidneys are all enlarged, reddened, mottled with paler spots, and with occasional petechiæ. The mesenteric glands have undergone the greatest change. They are all very much enlarged, of a peculiar yellowish green color. When the peritoneal covering is torn away, they appear made up of numerous whitish follicles.

Bacteriological observations.—No bacteria were detected in the internal organs with the microscope. Cultures on agar and gelatin plates were made from the liver, mesenteric gland, and lung tissue. Agar and bouillon peptone tubes were inoculated from the spleen, mesenteric, and inguinal glands. While the plate cultures indicated the presence of but very few germs in the various organs, the agar and bouillon cultures developed quite a variety. Each organ examined contained several forms. Thus in the bouillon peptone cultures from the blood a streptococcus and a very delicate true spirillum (not a comma bacillus) developed which could not be isolated. From the lung plates the swine-plague germ was obtained besides several other forms. In the spleen tubes the swine-plague germ appeared besides other forms. From the mesenteric glands *B. coli* was obtained. No pathogenic organism was thus found in this pig save the swine-plague germ, which was itself very much attenuated. One rabbit inoculated with a bit of diseased lung tissue died in nine days. There was extensive purulent infiltration of the subcutaneous tissue, starting from the place of inoculation and extending over abdomen and thorax. In the spleen and blood, the swine-plague germ only was present. In another rabbit, inoculated from a culture of this same germ, an abscess developed at the place of inoculation. This case was thus not satisfactory in spite of the large amount of time and labor spent upon it. Probably the hog-cholera bacteria had disappeared from the body, leaving it sufficiently weakened as a prey to other bacteria whose entrance into the closed cavities was favored by the numerous ulcers in the intestines. The following case is more to the point:

Pig No. 4 received at the station at the same time (September 4). It died late September 24, and was kept in refrigerator until next morning.

Autopsy notes.—Small female, weighs about 30 pounds. The mucosa of fundus of stomach intensely hyperæmic, associated with what appears to be slight, superficial necrosis. The entire length of the ileum has its mucosa covered with a layer of exudate, stained yellow, easily removed with the fingers. It is elastic, no

readily broken up or torn, about 1 millimeter thick. In some places it adheres firmly enough to require scraping and pulling. The subjacent membrane is roughened, discolored. The walls of the intestine are much thickened. On serous aspect patches of punctiform hemorrhage. In the cæcum and colon there is superficial necrosis of the mucosa. Attached to it loosely, here and there, are small, shreddy masses of exudate, stained yellow. Only one ulcer found penetrating the mucosa. The walls of the large intestine considerably thickened and œdematous. Liver firmer than normal, with scattering lobules of a deep red color. On section, a gritty sensation imparted to knife. Bile in bladder very thick, owing to the suspension of scaly masses. Evident degeneration of cortex of kidneys. The urine free from casts and albumen. Spleen moderately enlarged. In it a considerable number of embolic foci, which feel like shot.

Both lungs symmetrically diseased. The ventral lobes, the median lobe, and about one-sixth of both principal lobes (median edge) hepatized, bright red, mottled regularly with faint yellowish points. In the cephalic lobes several small areas of collapse. From the small air tubes of the hepatized lobes protrude, on pressure, semisolid yellowish plugs of muco-pus. The larger tubes contain a more liquid secretion. In the main bronchi and trachea a small quantity of viscid muco-pus.

Bacteriological examination.—Cover-glass preparations of spleen pulp show a large number of rod-shaped bacteria, closely resembling hog-cholera bacilli in size and mode of staining. A bouillon peptone culture inoculated with spleen pulp is quite turbid on the following day and contains only motile bacilli like those found in cover-glass preparations. Two gelatin roll cultures made from a bit of spleen pulp showed within a few days an immense number of identical, nonliquefying colonies in the first tube and about 75 in the second. The latter spread on the surface of the gelatin as round disc-shaped bodies of a pearly luster reaching a diameter after one or two weeks of two to three millimeters. The gelatin was not liquefied at any time. The deep colonies are spherical, brownish by transmitted light with faintly granular disc from one half to three-fourths millimeter in diameter. In short, they appeared in all respects like Bacillus ζ.

In the liver, the same bacilli were found in large numbers in cover-glass preparations. A bouillon peptone and a gelatin roll culture contained the same bacilli found in spleen cultures and these only.

Gelatin roll cultures from the mesenteric glands contained colonies of the same bacilli and these only.

From the diseased lung tissue agar plates were made. These unfortunately dried out very rapidly after the first day at which date no growth was yet visible. At the same time a rabbit was inoculated by placing a bit of lung tissue under the skin. It died within thirty-six hours. The local lesion was slight and peritonitis absent. In heart's blood and spleen numerous swine-plague bacteria detected with the microscope. Cultures from these organs contain the same bacteria and these only.

Gelatin plates from diphtheritic patches of small intestine contained after a few days chiefly colonies of *B. coli.*

The hog-cholera bacilli were thus present in considerable numbers in the spleen, liver, and mesenteric glands. It was now necessary to determine whether this bacillus could produce disease, and, if so, the nature of the disease. For this purpose rabbits were used.

September 25. Rabbit received under the skin of the thigh, with a hypodermic syringe, one-quarter cubic centimeter of the bouillon culture derived from the pig's spleen. The temperature of the rabbit rose 2° to 3° F. during the week following inoculation, then gradually subsided. It was killed October 7, twelve days after inoculation, at that time apparently well. At the place of inoculation there was a small amount of purulent infiltration. The subcutaneous inoculation had thus failed, as it frequently did in case of Bacillus ζ from the Maryland disease. Intravenous inoculation was next tried with entire success, and any doubt as to the identity of this organism with Bacillus ζ thus vanished.

September 30. One-quarter cubic centimeter of a bouillon peptone culture derived from a colony in the spleen roll was injected into the ear vein of a rabbit. Its temperature on the following day 106.4° F. It was found dead October 3. The lesions consisted in a swelling of Peyer's patches and in the infiltration of the follicles in the cæcum, giving them the appearance of whitish dots. The spleen was engorged and contained the injected bacilli in considerable numbers.

From a bouillon culture obtained from this rabbit two fresh rabbits were inoculated, receiving into the ear vein one-eighth and one-sixteenth cubic centimeter, respectively. In order to gauge these small quanties accurately the culture liquid was diluted. The one which had received one-sixteenth cubic centimeter died in four days. The spleen engorged, patches of necrosis in the liver. Peyer's patches pigmented, rather prominent. Urine albuminous. The injected bacilli numerous in spleen and liver. Cultures confirmatory. The rabbit which had received one-eighth cubic centimeter was dead within three days. The spleen engorged, Peyer's patches, and follicles in the cæcum swollen. In the spleen numerous hog-cholera bacilli. Cultures confirmatory.

These small quantities still being sufficient to kill rabbits, one-fiftieth cubic centimeter bouillon culture derived from a spleen colony was injected into the ear vein of another rabbit October 12. It died October 17. A small number of follicles in cæcum are infiltrated, enlarged, and appear as whitish elevated dots from both serous and mucous surfaces. In Peyer's patches are a few follicles similarly affected. In the liver what appears to be necrosis in small patches. Spleen moderately engorged. In spleen and liver very few bacilli.

The contagiousness of this form of hog cholera was very feeble. On September 18, six days before the second diseased pig died, a healthy pig in good condition was placed in the same pen with it. The animal, apparently well for several months, became unthrifty. Its body was covered with thick crusts when it was killed, December 9. The only discoverable evidences of infection were several cicatrices in the large intestine and one healing ulcer to which a friable slough was still attached.

EXPERIMENTS ON THE PRODUCTION OF IMMUNITY IN RABBITS AND GUINEA-PIGS WITH REFERENCE TO HOG-CHOLERA AND SWINE-PLAGUE BACTERIA.

By Theobald Smith and Veranus A. Moore.

In the following pages are brought together a series of experiments carried on during the past four or five years. They owe their origin to various causes, first among which was the necessity of learning something of the nature of the action of hog-cholera and swine-plague bacteria in the animal body. The failure to produce immunity in swine by the injection of small doses of virulent bacteria under the skin* made further studies of the problem of immunity necessary. This study could be best prosecuted on small animals, and for this reason rabbits and guinea-pigs were chosen.

Some of the investigations were made to examine into the claim of Metchnikoff† that immunity could be easily produced in rabbits towards hog cholera by the use of blood serum from immune rabbits. Our results had thus far been at variance with these, and proved to be totally so after repeating his work. Near the close of the investigation it was discovered that Metchnikoff had experimented with the swine-plague bacillus and not with the hog-cholera bacillus. This cleared up the difficulty. The detailed account of our observations will, without doubt, help to correct the wrong impression created by the misnaming of bacteria by Metchnikoff.

We have refrained from quoting or summarizing the now voluminous literature on the production of immunity in animals by the different processes which we have employed. The work is simply a contribution to the study of two specific pathogenic bacteria, and only those investigations are taken into consideration which deal with these bacteria. No claim is made for any new facts within the domain of immunity, excepting in so far as they apply to the disease germs experimented with.

The results obtained are, however, of special importance in shedding additional light on the divergent behavior of different species of bac-

* Report of the Bureau of Animal Industry for 1886, pp. 50–70.

† Études sur l'Immunité (5e mémoire); immunité des lapins vaccinés contre le microbe du hog-choléra. Annales de l'Institut Pasteur, VI, 1892, p. 289.

teria acting as causes of disease, as well as the marked difference in the receptivity of different species of animals towards the same disease germ.

HOG CHOLERA.

THE PRODUCTION OF IMMUNITY IN RABBITS WITH CULTURES OF ATTENUATED HOG-CHOLERA BACILLI.

Historically, the method of using attenuated cultures to produce immunity precedes that of other methods, and we, therefore, introduce the subject by detailing some experiments made in this direction.

These were begun as far back as 1889. The method of attenuation, based on that of Pasteur in the preparation of anthrax vaccines, consisted in exposing cultures in peptone bouillon to a temperature of 43.5° to 44° C. for a variable length of time. As the bacilli die out after a time in cultures at this high temperature, a fresh tube was inoculated every ten days, placed over night in a temperature favorable to multiplication, such as 37° C., and then restored to the temperature of 43.5° to 44° C. next day. This general plan suffered occasional interruptions, owing to disturbances in the thermostat employed, sudden changes of weather, which deranged the latter, and other accidents not infrequent in experimental work. From time to time rabbits were inoculated to observe any attenuation which may have taken place. During the process of attenuation certain changes in the appearance of the cultures were noticed. There was an increased deposit of bacilli which, when shaken up, appeared in flocculi and lumps of a whitish color. The great coherence of the bacilli, together with the tendency to form a brittle surface membrane, was not observed in cultures not exposed to heat. The bacilli appeared in small clumps in the hanging drop. Their motility was but slightly impaired and the clumps moved about very vigorously. After the systematic exposure to 43.5° to 44° C. had been stopped and the culture kept by inoculation from one agar tube to another, these modifications were still observed whenever fresh bouillon was inoculated. They had therefore become more or less permanent during the long-continued process of attenuation.

With the culture thus exposed to a high temperature rabbits were inoculated from time to time. After one hundred and seventeen days of exposure, comprising about eleven reinoculations into fresh bouillon, 0.1 cc. of the culture fluid was fatal to only one-third of the rabbits inoculated subcutaneously. The same may be said of the culture after one hundred and ninety-five days. In all rabbits there was noticed, however, a rise of temperature to 104° F. or 106° F. several days after inoculation. This fever continued a variable number of days.

Without wearying the reader with any detailed account of the animals treated we may briefly summarize the preliminary results by the statement that the immunizing action was not entirely uniform. Some

eated cases died from inoculation with unattenuated cultures after a otracted illness; others fully recovered. The fact, however, was monstrated that immunity in the very susceptible tame rabbit could produced with cultures attenuated at a high dysgenetic tempera- re. The process of inducing immunity proved to be a very tedious e and checkered with many failures.

The discovery in 1889 of a distinct variety of the hog-cholera bacillus acillus ζ, p. 13) with less pathogenic power made it desirable to deter- ine whether rabbits could be made immune to the virulent variety ter one or more inoculations with the less virulent variety. The portunity for such a test was offered by the fact that Bacillus ζ was tal to rabbits only when one-fourth of a cubic centimeter or more of a uillon culture was injected subcutaneously. A preliminary attenua- on was thus unnecessary. The method followed was to inject up to 2 cc. subcutaneously or from .003 cc. to .02 cc. (diluted) into an ear in. When one or two months later the usual fatal dose of virulent g-cholera bacilli was injected under the skin only 3 out of 8 rabbits rvived. It is probable that if a second injection of the weaker riety had been made before the test inoculation the majority would ve survived. This experiment thus confirmed the preceding, in tablishing the fact that immunity could be produced in this way.

From these two series of experiments of 1889–'90 two rabbits were ill living in 1892. They had been kept for further investigation, but her work interfered. During this interval they had successfully sisted the subcutaneous injection of the usually fatal dose of hog- olera bacilli at two different times. The tags belonging to these rab- its had been lost, so that it was impossible to determine to which series ey belonged. Their continued immunity was demonstrated by the llowing inoculations:

July 29, 1892. Rabbit A., large white animal, weighing 5 pounds; subcutaneous oculation of 0.1 cc. of a virulent bouillon culture.

August 1. 107° F.

August 4. 103.9° F. Swelling one-half inch thick at seat of inoculation.

August 13. 103° F.

September 15. 102.6° F. Subcutaneous inoculation with 0.2 cc. of a virulent cul- re.

September 17. 103° F.

September 19. 103.2° F.

September 21. 103° F.

October 5. Intravenous injection of 0.06 cc. of a virulent bouillon culture.

October 7. 102.2° F.

This animal, supposed to have recovered entirely, died suddenly on November 8, ver a month after the last inoculation. The autopsy was negative, excepting as to he brain. In the caudal portion of the right hemisphere there was a firm whitish umor about 6 to 7 mm. in diameter. The microscopic examination of sections of ardened brain tissue revealed an abscess containing clumps of hog-cholera bacilli. he brain was examined because the person in charge of the animal room reported hat the head of the rabbit had been drawn to one side one or more days before death.

July 29, 1892. Rabbit B, large yellow male; weighs 5.37 pounds. Subcutaneous njection of 0.1 cc. of a virulent bouillon culture.

August 1. 103° F.
August 4. 102.8° F.
August 13. 103° F.
September 15. Subcutaneous injection of 0.2 cc. of a virulent culture.
September 17. 103.4° F.
September 19. 102.6° F.
September 21. 102.8° F.
It is not improbable that the age of these two rabbits contributed, to a slight extent, to their continued powers of resistance.

From 1889 to 1892 no new work was attempted in this direction. In the latter year several things conspired to make a repetition of this work desirable. A remarkably weakened culture of the virulent hog-cholera bacillus attenuated in cultures, containing *Proteus vulgaris*, was in our possession. Metchnikoff had just published an article claiming to have readily produced immunity in rabbits by injecting the blood serum from rabbits previously immunized, by another method, against the hog-cholera bacillus. Improbable as these results seemed, they yet demanded reëxamination in the interest of some method of vaccination for swine.

Hence the attenuated hog-cholera culture was employed in the immunization of rabbits which were to furnish the blood serum to be used in repeating a portion of Metchnikoff's work.

The attempts at producing immunity were fraught with many failures, and only two rabbits were finally made insusceptible. The failures were due at first to a too rapid process of immunization, later on to a gradual return to virulence of the vaccinal culture, and to the accidents incidental to keeping animals for a long period of time. In some cases rabbits passed successfully through two inoculations, to be killed by the third, more severe test. The following is the history of the two rabbits which acquired a pretty high degree of resistance.* The details are of sufficient interest to warrant reproduction here.

White rabbit, No. 205, weight about 3 pounds at the beginning of experiment.

1. January 23, 1892. Receives a subcutaneous injection of 0. 2 cc. of vaccinal culture; lesion at point of injection slight; temperature rose only to 103° F.
2. April 13. Subcutaneous injection of 0.15 cc. of same culture.
   April 18. 103.4° F.
   April 21. 103° F.
3. May 21. Intravenous injection of 0.04 cc. of same culture diluted in 10 volumes of sterile bouillon.
   May 23. 105.2° F.
   May 25. 102.8° F.
   May 27. 102.4° F.
4. June 30. Intravenous injection of 0.1 cc. of same culture.
   July 1. 106.8° F.
5. July 29. Subcutaneous injection of 0.1 cc. of a virulent bouillon culture of hog-cholera bacilli.
   August 1. 103.9° F. Seat of inoculation reddened and swollen.

* For the experiments to determine the protective power of the blood serum from these rabbits see p. 61.

August 4. 103.8° F. Swelling as before; control rabbit dead.
August 12. 103.6° F.
September 15. Temperature 103° F; subcutaneous injection of 0.15 cc. of a virulent bouillon culture of hog-cholera bacilli.*
September 17. 103° F.
September 19. 102.8° F.
September 21. 102.4° F.
October 20. Weight, 3¾ pounds.
November 15. Weight, 4 pounds.

White male rabbit, No. 232, weighing 3 pounds.

February 6, 1892. Subcutaneous inoculation with 0.2 cc. of vaccinal bouillon culture.
February 8. 102.5° F.
February 11. 104° F.
February 13. 106° F.
February 15. 104° F.
February 17. 103.4° F.
February 18. 103.7° F.
February 23. 103.4° F.: firm swelling about one-half inch thick at seat of inoculation.
March 2. 102.4° F.
May 21. Intravenous injection of 0.04 cc. of vaccinal culture.
May 23. 100.4° F; rabbit apparently quite ill.
May 25. 102.4° F; rabbit better.
May 27. 103° F.
June 30, intravenous injection of 0.1 cc. vaccinal culture.
July 1. 104.2° F.
July 29, subcutaneous injection of 0.1 cc. of a virulent culture.
August 1. 103.7° F; red swelling at seat of inoculation.
August 4. 103.5° F; (control rabbit dead).
August 13. 103.4° F.
November 15. Weights 3¼ pounds; has not gained during the process of vaccination.

These two rabbits were thus made insusceptible to a fatal subcutaneous dose of hog-cholera bacilli. No. 205 was twice tested with such a dose; No. 232 but once. The following case is interesting, for the vaccination was entirely intravenous, and the degree of immunity acquired is quite high.

No. 281, gray and white rabbit, weighing 3 pounds.

May 21, 1892. Intravenous injection of 0.02 cc. of the vaccinal bouillon culture, to which 10 volumes of sterile bouillon are added.
May 25. 105° F.
May 27, 104° F.
June 30. Intravenous injection of 0.06 cc. vaccinal culture.
July 1. 106.8° F.
July 29. Intravenous injection repeated; some of fluid passed into subcutis of ear; probable intravenous dose 0.1 cc.
July 30. 103.6° F.
July 31. 104.3° F.
August 4. 103.7° F.
August 12. 102.8° F.

* This stock culture being in constant use and found invariably fatal a control rabbit was not inoculated at this time.

4. September 15, weighs $4\frac{3}{16}$ pounds. Intravenous injection of 0.1 cc. of vaccinal culture.
September 17, 107.3° F.
September 19, 102.8° F.
September 21, 102° F.
5. October 5, subcutaneous injection of 0.06 cc. of a virulent bouillon culture diluted with sterile water.
October 19, rabbit dies to-day. Compression of spinal cord by ulcerated lumbar vertebræ. Either result of injury or of localization of injected bacteria. Paralysis of lower extremities was noticed some days before death. Even if we assume that the disease of the vertebræ was due to the injected bacteria, which is highly improbable, the injection having been made into the subcutis, there was still a decided resistance, since death occurred from ten to twelve days later than with unprotected rabbits.

THE PRODUCTION OF IMMUNITY WITH STERILIZED BOUILLON CULTURES OF HOG-CHOLERA BACTERIA.

The culture medium employed in these experiments, with one exception, was beef infusion, containing one-half per cent peptone, one-half per cent sodium chloride and a sufficient quantity of a normal solution of sodium carbonate to give it a faintly alkaline reaction as determined by litmus paper. It was sterilized by discontinuous boiling in tubes containing 30 cc. each. After their sterility was tested the tubes of bouillon were inoculated with hog-cholera bacteria and placed in an incubator at a temperature of 35–37° C. After a certain number of days (the cultures used varied in their age from five to twenty days) the cultures were exposed in a water bath to a temperature of 65° C. for two hours, after which they were returned to the incubator for from one to two days, when a tube of fresh bouillon was inoculated from each. The heated cultures were then placed in a refrigerator of about 7° C., where they were kept until used. If the freshly inoculated tubes remained clear the sterility of the heated cultures was considered assured. Before the injection of the sterilized culture fluid the quantity to be used was transferred to a sterile tube and raised to the temperature of the body.

A.—Experiments on Guinea-pigs.

The guinea-pigs used weighed from 12 to 16 ounces. They received the culture fluid subcutaneously over the abdomen. The injections were made at short intervals, usually only twenty-four hours intervening between them. To test the immunity acquired the animals were inoculated with 0.1 cc. of a fresh bouillon culture of virulent hog-cholera bacteria in from one to three days after the last injection of the sterilized liquid. In every experiment four guinea-pigs were used; two were treated and two reserved as controls.

The first experiment showed that 15 cc. of a sterilized culture, fifteen days old, injected in fourteen doses, would produce immunity. This very naturally led to the use of cultures of different ages and in smaller quantities. A question of much interest was to determine the

mber of doses into which it was necessary to divide the required
ount to produce a permanent resistance on the part of the animal.
this end several experiments were made, the necessary details of
ich are given, with the results obtained, in the subjoined table:

–Table showing the immunizing efficiency of sterilized bouillon cultures on guinea-pigs.

[illegible]	Guinea-pig number—	Quantity of sterilized culture fluid injected.	Number of injections.	Age of cultures when sterilized.	Time from first injection to inoculation.	Date of inoculation with living bacteria.	Control guinea-pigs died in—	Effect on treated guinea-pigs.
		c. c.		Days.	Days.		Days.	
	1	15	14	15	18	Aug. 26, 1890	8	Recovered.
...	2	15	14	15	18	....do	11	Do.
	3	10	10	15	12	Oct. 1, 1890	8	Died in 13 days.
...	4	10	10	15	12	....do	9	Recovered.
	5	10	10	10	11	Oct. 24, 1890	6	Do.
...	6	10	10	10	11	....do	6	Do.
	7	10	10	10	11	....do	6	Do.
...	8	10	10	10	11	....do	6	Do.
	9	10	10	20	17	Nov. 11, 1890	7	Killed Nov. 20.
...	10	10	10	20	17	....do	7	Died in 18 days.
	11	10	10	5	17	....do	7	Recovered.
...	12	10	10	5	17	....do	7	Do.
I..	13	10	6	10	16	Feb. 4, 1891	6	Died in 13 days.
	14	10	6	10	16	....do	12	Recovered.
II.	15	10	4	10	16	....do	6	Died in 12 days.
	16	10	4	10	16	....do	12	Recovered.
	17	10	3	15	12	Nov. 6, 1890	12	Died in 16 days.
...	18	10	3	15	12	....do	12	Died in 18 days.
	19	8	8	15	11	....do	6	Died in 11 days.
...	20	8	8	15	11	....do	6	Recovered.
	21	8	5	10	11	Oct. 24, 1890	6	Died in 7 days.
...	22	8	5	10	11	....do	6	Died in 9 days.
I*	23	†12	6	....	15	Feb. 4, 1891	6	Died in 6 days.
	24	†12	6	....	15	....do	12	Died in 8 days.

* Control experiment. † Peptonized bouillon.

The immediate toxic effect produced by the subcutaneous injection the sterilized bouillon cultures was barely observable. The liquid s rapidly absorbed, and in no case did it produce an appreciable itation. This fact was amply illustrated by the subcutaneous injec- on of 13 cubic centimeters of a sterilized bouillon culture that had own for ten days prior to its sterilization. A small guinea-pig was loroformed and the 13 cc. injected in as many places over the body. his produced a stupefied condition which lasted several hours. The uid was soon absorbed, leaving the subcutaneous tissue free from durations. The guinea-pig was inoculated subsequently with 0.1 cc. a bouillon culture of hog-cholera bacteria. It lived seven days nger than the check and exhibited a large number of tubercle-like odies beneath the peritoneum.*

It will be observed from the table that in addition to the guinea-pigs at received 15 cc. of the culture all of those that received 10 cc. of ve and ten day cultures in ten doses or injections were not seriously fected by the subsequent inoculation of hog-cholera virus. A smaller uantity of the culture fluid or a fewer number of injections were

* For a description of this modified form of the inoculation disease, see p. 87.

insufficient to produce immunity, for the inoculation with the strong virus was followed by severe local reaction and the death of a greater or less number of the animals. It is of interest to note that, as anticipated, no resistance was produced by the injection of the peptonized bouillon. (Experiment XII).

The course of the disease in the animals which had acquired a greater or less amount of resistance is exceedingly interesting. The most complete immunity was indicated by the absence of any marked reaction at the place of inoculation. The lesions of those that perished after a certain time exhibited a number of variations from those found in the checks. A slight resistance was characterized by severe local reaction and a greater resistance by certain changes in the organs. Usually a membranous exudate was found over the liver and spleen and the latter was not enlarged. The most marked peculiarity, however, was the formation of a considerable number of small, grayish, tubercle-like bodies. These were usually lenticular in form and varied from 0.25 to 2 mm. in length and from 0.1 to 1 mm. in width. They were distributed in the body as follows: Beneath the peritoneum, especially along the sides of the spinal column; beneath the pleura, more especially over the diaphragm; in the heart muscle, near the apex; and occasionally on the external surface of the abdominal wall. These bodies were firm to the touch. They consisted of a dense infiltration of round cells. Hog-cholera bacteria were present.

In the guinea-pigs which resisted for some days the spleen and liver contained very few bacteria, and frequently no bacilli could be found in cover-glass preparations from them. In similar preparations made from the tubercle-like bodies, crushed with forceps, there invariably appeared a considerable number of hog-cholera bacteria.

The disturbances noticed in the animals after their inoculation with the living bacteria and the more important lesions found upon post-mortem examination are of sufficient interest to deserve a somewhat more detailed statement. In the control animals the lesions found on post-mortem examination were, briefly stated, as follows:

At the point of inoculation a purulent infiltration into the subcutis extending over an area of from 2–4 cm. in diameter; the superficial layer of the subjacent muscle was usually discolored. Inguinal glands enlarged and reddened. Liver contained a greater or less number of necrotic foci. Spleen very much enlarged, dark-colored and friable. Peyer's patches pigmented, often swollen.

Experiment I.—Guinea-pig No. 1 developed a small swelling at the point of inoculation; otherwise both animals appeared perfectly well, and at the time the checks died they had an elevation of temperature of only about one degree. Three days later the temperature was normal. On October 1 they were reinoculated with 0.25 cc. of a bouillon culture of hog-cholera bacteria which produced a very slight local reaction. No elevation of temperature.

Experiment II.—At the time the checks died guinea-pigs Nos. 3 and 4 appeared to be well, if we except a small abscess at the point of inoculation; temperature 0.5° higher than at time of inoculation. Two days later No. 3 appeared to be sick, temperature 101° F. (Normal 102.8° F.) It was found dead on the second morning following. The post-mortem examination showed usual hog-cholera lesions with

ıall grayish tubercle-like bodies beneath the peritoneum on the abdominal wall. ·mphatic glands enlarged. No. 4 remained well.

Experiments III and IV.—Guinea-pigs Nos. 5, 6, 7 and 8 exhibited a slight rise in ıperature on the seventh day. A cyst (about the size of a small bean) formed at e point of inoculation, which ruptured and subsequently healed. Nos. 5 and 6 st no flesh, but Nos. 7 and 8 fell away 0.5 and 1.5 ounces, respectively.

Experiment V.—At the time the checks perished, guinea-pigs Nos. 9 and 10 appeared be well. Two days later No. 9 was killed for examination. It exhibited a hyper-nic condition of the abdominal viscera. Lymphatic glands enlarged. In No. 10, ıich died on the 18th day, there was a large local ulcer, exudative peritonitis, d a large number of tubercle-like bodies lying beneath the peritoneum along the 't side of the spinal column and beneath the pleura of the left lung. Considerable ·um in the pleural and peritoneal cavities.

Experiment VI.—Guinea-pigs Nos. 11 and 12 suffered from severe local reaction; a st (containing pus) as large as a walnut formed at the point of inoculation, over ıich the skin sloughed. They were sick for a few days, but recovered.

Experiment VII.—At the time the check died, guinea-pigs Nos. 13 and 14 appeared be perfectly well, if we except a slight swelling at the point of inoculation. bruary 14, both animals were sick. February 17, No. 13 was found dead with a all closed abscess at the point of inoculation. Beneath the peritoneum, on the dominal walls, and especially along the left side of the spinal column, were scat-·ed a large number of tubercle-like bodies. Lymphatic glands enlarged. Necrosis liver. A membranous exudate over spleen and liver; spleen not enlarged or dis-lored. Many of the follicles in Peyer's patches infiltrated. No bacteria discov-·d in cover-glass preparations from spleen and liver. Covers from the tubercle-e bodies exhibited many hog-cholera bacteria. Guinea-pig No. 14 recovered.

Experiment VIII.—Guinea-pigs Nos. 15 and 16, were very sick at the time the st check died. No. 15 perished with the second check. Usual hog-cholera lesions. . 16 lived but did not thrive.

Experiment IX.—Guinea-pigs Nos. 17 and 18 suffered from a large abscess at the int of inoculation. Spleens were enlarged and friable, otherwise they presented ions similar to those found in guinea-pig No. 13. (Experiment VII.)

Experiment X.—Guinea-pig No. 19 exhibited severe local reaction involving sub-·ent muscle. Spleen not enlarged. Liver, kidneys, and small intestine hyper-nic. The cephalic lobe of right lung in a state of red hepatization. No. 20 appar-tly perfectly well, excepting a swelling at point of inoculation, which soon bsided.

Experiment XI.—Although the guinea-pigs resisted one and three days respectively, lesions were practically identical with those found in the checks. Hog-cholera cteria were found in cover-glass preparations from the spleen and liver.

Experiment XII.—One of the guinea-pigs died with the first check and one died a y before the second check perished. They showed typical hog-cholera lesions.

It is of interest to note the difference in the effect on guinea-pigs ·tween the sterilized cultures of hog-cholera bacteria and solutions or ·spensions of the poisonous substances isolated from similar cultures. perusal of Dr. de Schweinitz's article * shows that the injection of e *sucholotoxin* and *sucholoalbumin*, which he obtained from the cul-res, produced severe local reaction, followed in some cases by "ugly cers which healed after from ten to fourteen days." The animals ·peared ill for several days after the injection, but eventually regained eir normal activity. The subsequent inoculation of hog-cholera virus

* Medical News, October 4, 1890.

showed that immunity had been induced when the quantity of the toxines injected had been sufficiently large. The guinea-pigs that died after resisting the disease for a certain number of days after the controls died were examined by one of us. They showed a greater or less number of tubercle-like bodies beneath the peritoneum. Unfortunately the number of injections that were made and the quantity of culture fluid represented in the toxines used are not given, so that further comparisons can not be made.

In the spring and summer of 1893, a few similar experiments were made on guinea-pigs for the purpose of obtaining immune animals to be used in other investigations. The readiness with which guinea-pigs had been made resistant to hog cholera in 1890 led to the supposition that the same results could be obtained at any time. The following table indicates, however, that such is not the case. Although an equally virulent germ was used for making the cultures, and every particular pertaining to the previous experiment adhered to, it was with much difficulty that the necessary number of guinea-pigs were rendered immune or at least resistant to the inoculation of virulent hog-cholera bacteria. The results of these experiments are recorded in Table No. 2, appended.

II.—*Table showing the immunizing effect of sterilized bouillon cultures of hog-cholera bacteria (1893).*

Experiments.	Guinea-pig number—	Quantity of sterilized culture fluid injected.	Number of injections.	Age of cultures when sterilized.	Time from first injection to inoculation.	Date of inoculation with living bacteria.	Control guinea-pigs died in—	Effect on treated guinea pigs.
		cc.		*Days.*	*Days.*		*Days.*	
XIII	417	10	10	9	29	Jan. 22, 1893	9	Died in 13 days. Emaciated.
	418	12	12	9	29	... do	9	Died in 6 days. Typical hog-cholera lesions.
	419	12	12	9	29	....do	9	Do.
XIV	437	10	10	9	17	Jan. 21, 1893	9	Died in 16 days. Tubercle-like bodies beneath peritoneum.
	438	10	10	9	17	....do	9	Died in 44 days. No lesions, no bacteria.
	439	10	10	9	17	....do	9	Died in 14 days. Tubercle-like bodies beneath peritoneum.
XV	451	12	9	15	20	July 27, 1893	8	Died in 10 days. Typical hog-cholera lesions.
	452	12	9	11	20	....do	8	Died in 11 days. Typical hog-cholera lesions.
	453	12	9	11	20	....do	8	Recovered.
	454	12	9	11	20	....do	8	Died in 18 days. Tubercle-like bodies beneath the peritoneum; hog-cholera bacteria.
XIV *	473	12	13	23	19	Sept. 23, 1893	6	Recovered.
	474	13	13	23	19	....do	6	Do.
	475	13	13	23	19	....do	6	Died in 18 days. Tubercle-like bodies beneath peritoneum and in heart muscle; hog-cholera bacterla.
	476	13	13	23	19	....do	6	Died in 9 days. Typical hog-cholera lesions.
	477	13	13	23	19	....do	6	Died in 10 days† Hog cholera lesions.
	478	13	13	23	19	....do	6	Died in 15 days. Fatty liver, many hog-cholera bacteria.

*In this experiment bouillon containing a small quantity of dextrose was used. The bacteria were allowed to grow until the fermentation was completed and the liquid became alkaline, when a few more drops of the dextrose solution was added. This stimulated the growth of the bacteria. When used the liquid was alkaline in reaction.

†The post-mortem examination of these two animals showed that the injection had been made accidentally, into muscular wall of abdomen.

The lesions produced in the guinea-pigs used in the second set of periments did not differ materially from those found in the animals the first experiments. Attention is called to the resistance main-ined by guinea-pigs Nos. 437, 438, 439, 454, 475, and 478. The cause death of No. 438 was not determined, as there were no lesions dis-vered and no bacteria obtained in cultures from the organs. In the her cases the lesions were characteristic of hog cholera, modified in nsequence of an increased resistance on the part of the animal. It probable that Nos. 476 and 477 would have survived if the strong rus had not been injected into the muscular tissue.

The difference in the outcome between the experiments of 1890 and 93 can not be satisfactorily explained. It is possible that it was due the greater susceptibility of the guinea-pigs or to some difference the cultures. The fact should be stated, however, that the hog-olera bacteria used were as virulent as those used in 1890. The sea-n may have had some effect in producing the divergent results, as e experiments in 1893 were made during the heat of summer, while e very positive results of 1890 were obtained during a cooler portion the year.

B.—Experiments on Rabbits.

The certainty with which guinea-pigs could be rendered immune by e use of sterilized cultures in 1890 led to a comparative test on rab-ts. Experience with rabbits since 1885 in this laboratory has shown at they are invariably susceptible to hog-cholera bacteria. The periment on guinea-pigs demonstrated the fact that the principle volved, and for the first time brought out in the pigeon experiments 1885, was applicable to at least one species of mammals which is ry susceptible to hog-cholera bacteria, and thus it answers the charge ade by Chantemesse and Widal* that the experiments on pigeons oved nothing because the method failed on susceptible mammals. ne experiments on rabbits about to be recorded illustrates very con-usively our inability to draw general conclusions from experiments one species of animals.

Two small white rabbits received, each, in the subcutaneous tissue, 11 doses, 20 cc. of sterilized bouillon cultures of hog-cholera bacte-a. They were subsequently inoculated, together with two untreated bbits, with one-eighth cubic centimeter of a bouillon culture of hog-olera bacteria. They perished with the checks, one in six, the other in ven days after the inoculation. It is instructive to note that *no sistance* to the disease was produced, although each rabbit received one ibic centimeter of sterilized culture fluid for each 1½ ounces of body eight, which quantity was sufficient to produce perfect immunity in inea-pigs in 1890. The injection of the sterilized culture produced

* Annales de l'Institut Pasteur, II (1888), p. 54.

manifestly no ill effect on the rabbits. The fluid was rapidly absorbed and left no thickening of the subcutaneous tissue.

A third rabbit received 11.4 cc. of sterilized bouillon culture in the ear vein in four injections, at intervals extending over a period of twenty-four days. The first injection (3 cc.), was followed by a temperature elevation of 2° F. On the following day the temperature was above normal. The second injection, of a like quantity, was followed immediately by accelerated respiration and purging (feces blood-stained). The temperature was elevated as after the first injection. The third and fourth injections produced similar but less intense reactions. Unfortunately the rabbit was injured a few days after the fourth injection and hence chloroformed and examined very carefully, but no lesions could be detected.

A fourth rabbit, injected intravenously with 3 cc. of a similar culture, was found dead in three hours.

A fifth rabbit, received in the veins 6.25 cc. in four doses, at intervals extending over a period of thirty-four days. After each injection it exhibited symptoms similar to those already described. It became much emaciated, but otherwise appeared to be well at the time of the test. It died in five days after its inoculation with the virulent culture of hog-cholera bacilli.

EXPERIMENTS WITH STERILIZED AGAR CULTURES OF HOG-CHOLERA BACTERIA.

The agar cultures used in these experiments were prepared as follows: Large tubes (1 inch in diameter) containing 1.5 cc. of agar* were inclined, and the surface inoculated with hog-cholera bacteria. The inoculated tubes were placed in the incubator for several days when the growth on the inclined surface was washed down with sterilized beef broth and transferred by means of a flamed pipette to sterile tubes. A sufficient quantity (usually 10 cc. of sterile beef broth to the growth on four tubes of agar) of liquid was added to make a turbid suspension. When the suspension was to be injected into the veins, it was filtered through sterilized Japanese filter paper, which removed all pieces of agar that might be present. It was sterilized by an exposure to 60° C. for one hour in a water bath, after which it was returned to the incubator for one day. Its sterility was then tested by inoculating fresh tubes of bouillon. If these remained clear the death of the bacteria was considered as positive. The heated cultures were kept, until used, in a cold chamber at a temperature of from 7–9° C.

* In the preparation of the agar for this purpose, it was found that the addition of one-eighth to one-tenth per cent of white glue was beneficial in giving to the inclined agar a more firm surface from which the growth could be easily removed. The glue did not interfere with the growth of the hog-cholera bacteria, as shown by parallel cultures on ordinary agar.

A.—EXPERIMENTS ON GUINEA-PIGS.

A few experiments on guinea-pigs with sterilized agar cultures were ıade. The facts necessary for a full understanding of these test experiıents are given in the appended table:

III.—*Table showing the immunizing effect of sterilized agar cultures on guinea-pigs.*

ıuinea-g num-ber—	Quantity of sterilized agar cul-ture in-jected.	Number of injec-tions.	Time from first injection to inocula-tion.	Date of inoculation.	Control guinea-pigs died in—	Effect on treated guinea-pigs.
	cc.				*Days.*	
23	1.5	1	....	....	....	Died in 20 hours after the injection.
24	1.5	1	13	June 30, 1891	6	Died in 8 days.
25	2.0	2	11	....do	6	Died in 9 days.
26	3.5	3	11	....do	6	Died in 15 days.
27	3.5	7	11	June 23, 1893	6	Died in 12 days.
28	3.5	7	11	....do	6	Do.

Guinea-pig No. 23 found to be pregnant, which may explain the fatal toxic effect.

Guinea-pig No. 24 developed a large swelling where fluid was injected, which sulted in the formation of a caseous tumor. The guinea-pig was sick for several ıys after the injection. It resisted two days. Liver pale, contained necrotic foci. ıleen not enlarged.

Guinea-pig No. 25 exhibited a very large discolored spleen. The injection of the spension of agar growth produced a small cyst containing a yellowish caseous subance. The local reaction of the hog-cholera virus was very slight.

Guinea-pig No. 26 was apparently perfectly well when No. 25 died, excepting a velling about the size of a small walnut at the point of inoculation. It lived nine ıys after the check died. The post mortem showed a membranous exudate over liver ıd spleen, the latter slightly enlarged; tubercle-like bodies on the external surface the abdominal wall and heart muscle. No hog-cholera bacteria in cover-glass eparations from the liver.

Guinea-pig No 28 exhibited lesions which did not differ from those found in the ıeck.

Guinea-pig No. 27 contained lesions similar to those found in No. 26.

B.—EXPERIMENTS ON RABBITS.

The rabbits used were young adults. They were kept in large wire ıges during their treatment at the Experiment Station of the Bureau. he animals were somewhat carefully watched after the various injecons by Dr. F. L. Kilborne, but their temperature was not taken. sually about six days intervened between the injections. When the ıbbits did not thrive a longer period was allowed to elapse between ıem. The results of the preliminary experiments, together with the ecessary details, are given in tabulated form :

IV.—*Table showing the immunizing effect of sterilized agar cultures on rabbits.*

Rabbit number—	Quantity of sterilized suspension injected.	Method of injection.	Number of injections.	Age of cultures when sterilized.	Time from first injection to inoculation.	Date of inoculation with hog-cholera bacteria.	Control rabbits died in—	Effect on treated rabbits.
	cc.			*Days.*	*Days.*		*Days.*	
48	2.75	Ear vein......	3	2	14	June 26, 1891	4	Died in 7 days.
49	.5	....do.........	1	2	....	....	....	Died a few hours after the first injection.
55	1.5	....do.........	2	2	14	June 26, 1891	4	Died in 7 days.
62	2.5	....do.........	3	2	....	....	....	Died after third injection.
63	1.5	....do.........	2	2	....	....	....	Died after second injection.
64	1.5	....do.........	2	2	....	....	....	Do.
65	6.25	....do.........	8	2	80	Sept. 9, 1891	5	Died in 6 days.
58	4.5	Abdominal cavity.	4	2	28	July 20, 1891	6	Do.
59	7.5	....do.........	6	2	69	Sept. 1, 1891	6	Do.
60	11.5	....do.........	8	2	78	Sept. 9, 1891	5	Do.
61	17	....do.........	10	2	90	Oct. 1, 1891	6	Do.
66	6	Beneath the skin.	4	2	28	July 20, 1891	6	Died in 4 days.
67	10	....do.........	6	2	69	Sept. 1, 1891	5	Died in 6 days.
68	15	....do.........	8	2	88	Sept. 8, 1891	4	Died in 5 days.
69	22	....do.........	10	2	98	Oct. 8, 1891	6	Do.

A glance at the table will show that the immunizing power of sterilized agar cultures on rabbits in the quantities used and according to the methods employed was *nil.* The lesions found in the rabbits that perished after the second and third injections are interesting, as they resembled somewhat those produced by the living bacteria. (*See* notes on Nos. 62 and 63 below.) The immediate effect of the injection was marked by depression and apparent illness. The immunity was tested by inoculating the rabbits subcutaneously with 0.05 cc. of a bouillon culture of hog-cholera bacteria (the same as used for the agar cultures) which was sufficiently virulent to destroy rabbits, in the dose given, in from five to seven days. Control rabbits were always used.*

Rabbit No. 49 died in a few hours after the first injection. The examination showed a general hyperæmic condition of the thoracic and abdominal organs. No bacteria.

Rabbits Nos. 48 and 55 showed greater local reaction than that found in the control rabbit.

Rabbit No. 62 died after the third injection of the sterilized agar culture. It had lost no appreciable amount of flesh during the treatment. The examination revealed the following conditions: Several small blood extravasations beneath the serosa in the upper colon and in the rectum. Intestines hyperæmic. In liver a large number of pale reddish areas resembling beginning necrosis. Spleen enlarged, dark colored, friable. Cortex of kidney pale, medullary portion of a bright red color. Lungs hyperæmic, partially collapsed. Heart muscle pale, sprinkled with punctiform hemorrhages. Agar tubes inoculated with pieces of the liver remained sterile.

Rabbits Nos. 63 and 64 perished after the second injection. The lesions were characterized by an enlarged spleen and liver and punctiform hemorrhages in colon and abnormally pale heart muscle. Culture media inoculated from the liver remained sterile.

* For the lesions of hog cholera in rabbits, see p. 10.

No. 65 lived one day longer than the check. It exhibited typical hog-cholera sions.

Rabbits Nos. 58 to 61 and 66 to 69 presented lesions characteristic of hog cholera, id in no case was there any evidence of increased resistance. The lesions were actically identical with those produced in the control rabbits.

These results led to a second series of experiments on rabbits in hich the immediate effect of the sterilized cultures was more carefully oted. The suspension of the agar growth was prepared, sterilized and ie rabbits injected intravenously as in the preceding experiments:

.—*Table showing the intravenous injection of sterilized agar cultures of hog-colera bacteria.*

abbit num-er—	Age of culture when sterilized.	Quantity of agar suspension injected.	Number of doses.	Time from first injection to inoculation or death.	Date of inoculation with hog-cholera bacteria.	Results.
	Days.	*cc.*		*Days.*		
107	2	9.5	9	42	....	Very poor, chloroformed for examination.
109	2	7	7	37	Oct. 10, 1891	Died with check.
113	2	1	1	4	....	Poor, chloroformed for examination.
114	2	2	2	7	....	Do.
123	2	6.5	3	23	Oct. 10, 1891	Died 2 days after check.
150	2	7.4	4	39	Nov. 19, 1891	Died with check in 5 days.
110	5	9.8	9	55	....	Died October 30, emaciated and anæmic.
111	5	6.5	6	35	Oct. 10, 1891	Died October 15, with check.

The immediate effect of the sterilized suspension was very marked. sually the rabbits were purged within thirty minutes after the injecon. In a few of the cases the later injections were followed by the vacuation of blood-stained stools.* The temperature was elevated om 1 to 3° F. within three hours. The maximum temperature was eached in about twenty hours. It continued above normal for from vo to three days. Respiration was accelerated. The rabbits remained ery quiet, sat in a crouched position, and usually the eyes were nearly losed. They ate very little the first day after the injection. After the econd day they were usually bright and seemed to be quite well. These ymptoms were repeated after each injection. The rabbits became emaiated. Those killed for examination revealed no macroscopic lesions, xcepting that of anæmia. Those subsequently inoculated with hogholera virus, offered no resistance to the disease.

The maximum quantity of the sterilized suspension injected at one ime was 3 cc. which was not sufficient, however, to produce death. It

* It is of interest to note that the severe symptoms produced by the intravenous njection of the agar suspension did not follow the introduction of the filtrate. his was determined by preparing a certain quantity of the suspension, placing it an incubator for twenty-four hours, filtering it through a bougie of a Pasteur filter nd injecting from 1 to 2 cc. of the filtrate into the ear vein of rabbits. The injecion was followed by a rise in temperature of from 1.5 to 2.6° F., which subsided vithin eighteen hours. No other symptoms were detected. The injection of a similar quantity of sterile peptonized bouillon or normal salt solution likewise produced slight rise of temperature

was observed that when large quantities were injected at first, subsequent injections produced a milder reaction. Tubes of bouillon or agar were always inoculated with bits of tissue from the spleen or liver of the rabbits that died from the effect of the injections. These invariably remained sterile.

C.—Experiments on Pigs.

In order to extend the comparison between the immunizing effect of sterilized bouillon and agar cultures of hog-cholera bacteria, two experiments were made on pigs. The marked resistance obtained in the guinea-pigs with a small quantity of sterilized agar suspension indicated that this substance was more effective than the sterilized bouillon cultures. The effect on rabbits also indicated the presence of a more powerful substance in the agar culture than in the simple bouillon growths, although no immunizing properties were shown.

In the first experiment on pigs a suspension from an agar culture was used that was similar in concentration to that employed in the experiments on other animals. In the second trial the same quantity was injected but the suspension contained the growth from twice the area of agar surface used for the first. The total quantity given each time was divided into several doses, which were injected in different places beneath the skin, on the inside of the thigh, and over the abdomen.

The pigs selected were 3 months old and weighed from 45 to 50 pounds each. They were tested after the treatment by an intravenous inoculation of 6 cc. of a bouillon culture of hog-cholera bacteria. The other facts necessary for an understanding of these experiments are given in a tabulated form.

VI.—*Table showing experiments on pigs with sterilized agar cultures of hog-cholera bacteria.*

Experiment.	Pig number —	Quantity of emulsion injected.	Number of injections.	Time from first injection to inoculation with living bacteria.	Date of inoculation.	Controls died in—	Results.
		cc.		*Days.*		*Days.*	
I	59	50	3	34	Aug. 15, 1891		Died in 4 days.
	62	50	3	34	...do...		Died in 12 days; extensive ulceration in intestine.
	60	Control			...do...	3	
	61	Control			...do...	4	
II	67	50	3	26	Oct. 17, 1891		Died in 5 days.
	68	50	3	26	...do...		Recovered.
	71	50	3	26	...do...		Do.
	69	Control			...do...	3	
	70	Control			...do...	3	
	74	Control			...do...	4	

In the first experiment pig No. 62 lived eight days longer than the checks, and exhibited very extensive ulcerations of the intestinal tract with slight lesions elsewhere in the body. This fact indicated that a certain amount of resistance had been produced which manifested itself by an unusually marked localization of the disease. There were no

sions found at the points of injection of the sterilized agar suspension. In pig No. 67 there were several encysted abscesses in the subcutaneous tissue at the points where the agar suspension was injected. Pigs Nos. 68 and 71 were sick for a few days but fully recovered. The result of the second experiment was sufficiently positive to admit of the inference that two of the three pigs were made immune by the use of the agar cultures. The severity of the test inoculation is indicated by the fact that all of the control pigs and nearly all of the pigs (from the same herd) inoculated simultaneously in connection with certain other experiments carried on at this time perished. It is highly probable that pigs can be made insusceptible to the disease as acquired on the farm by repeated injections of sterilized suspensions of agar cultures. The attending expense of such a process, however, makes it impracticable.

EXPERIMENTS WITH THE BLOOD OF HOG-CHOLERA RABBITS STERILIZED BY HEAT.

In 1890 Selander* published some investigations in which he claimed to have produced, with the sterilized blood of swine-pest-infected pigeons, immunity in rabbits toward the bacillus of swine pest. This bacillus, according to personal observation of one of us, is identical with, or very closely related to, the hog-cholera bacillus, as found in this country.† The bacillus was passed by Selander through a long series of pigeons, and the blood of these pigeons, sterilized by heat, was used to produce immunity in rabbits. His experiments are briefly summarized as follows:

1. *Intravenous injections.*—A rabbit received in an ear vein, in three injections (April 19, May 5, and 9), 3.5 cc. in all of pigeon's blood, from the fifty-first, fifty-ninth, and sixty-sixth passages. The blood was heated for an hour at 57° C. Three days after the last injection the rabbit was inoculated with 0.15 cc. of pigeon's blood from seventy-first passage. It remained well. The control rabbit died in less than thirty-six hours. A second experiment was made, in which 4-5 cc. of sterilized blood was injected in 4 doses. Four days after the last injection the rabbit was inoculated with virulent pigeon's blood of the seventy-third passage. It remained well. The two control rabbits died in less than twelve hours.

2. *Subcutaneous injection.*—A rabbit received 15 cc. of sterilized blood in two doses (March 22, 5 cc.; April 18, 10 cc.). On May 13 it was inoculated subcutaneously with 15 cc. of blood of the seventy-first passage. It resisted, while the checks died in less than thirty-six hours.

The discrepancy between the pathogenic action of hog-cholera bacilli and that which Selander describes as characteristic of his culture was sufficient to arouse suspicion. This suspicion is strengthened by the statement of Metchnikoff that his work is a continuation of Selander's, and that he verified the latter's results. It has already been stated

* Contribution à l'étude de la maladie infectieuse des porcs connue sous les noms de hog-cholera, svinpest, pneumo-entérite infectieuse. Annales de l'Institut Pasteur, IV (1890), p. 545.

† See bulletin on Hog Cholera (1889), p. 181, for a history of the Danish disease.

that we have convicted Metchnikoff of working with the swine plague bacillus and calling it the hog-cholera bacillus in his publications. The evidence is thus very strong that through some inadvertence Selander worked with the swine-plague bacillus. However, as we have not been able to make a study of Selander's bacillus, his work is discussed here under hog cholera, and the reader will note in the following experiments a refutation of Selander's results as regards the hog-cholera bacillus, but a confirmation as regards the swine plague bacillus.

It was found in our experiments that rabbits inoculated with hog-cholera bacilli usually died during the night, and that it was impossible to obtain liquid blood from them post-mortem. For this reason rabbits were inoculated subcutaneously with hog-cholera bacteria, and in the last stage of the disease, presumably only a few hours before death would have occurred, they were killed by bleeding. The blood was collected in sterile tubes, defibrinated, and heated in a water bath for one hour at 58° C. In every case a gelatin roll culture was made prior to the heating with a small loop of the blood. In these innumerable colonies of hog-cholera bacteria developed, which showed that the blood contained enormous numbers of bacteria at the time the animals were killed. The heated blood was either used at once or kept at a low temperature (7–9° C.) until just before it was injected, when the required amount was heated to the body temperature. Previous experiments* had demonstrated the fact that hog-cholera bacteria are destroyed by exposing them to 58° C. for fifteen minutes. The certainty with which the bacteria are destroyed by such an exposure to heat led to the use of the blood in some cases immediately after it was heated, in order that no change might be produced by its standing. Its sterility, however, was tested in every case by subcultures in bouillon. These cultures invariably remained clear.

The rabbits from which the blood was obtained were inoculated subcutaneously with 0.1 cc. of a fresh bouillon culture of hog-cholera bacteria. A brief history of each of these animals is appended:

Rabbit No. 336, inoculated with virulent hog-cholera bacteria August 11, 1893; killed by bleeding August 15 (four and one-fourth days). The blood, after being sterilized, was kept at a temperature of from 7–8° C. for 20 hours, when it was used for the first injection.

Rabbit No. 310, inoculated August 15; bled August 19 (four and one-fourth days). The blood was used for the second injection immediately after it had been sterilized.

Rabbit No. 344, inoculated August 19; bled August 25 (six and one-fourth days). A portion of the blood was used immediately after it had been sterilized for the third injection. The remainder was kept at a temperature of from 7–8° C. for two days and then used for the fourth injection.

Rabbit No. 350, inoculated August 26; bled August 30 (four and one-fourth days). The blood was used immediately after its exposure to the heat for the fifth injection.

The post-mortem examination of the rabbits furnishing the blood showed, without exception, an enlarged spleen and necrosis in the liver. The three first were unable to stand when they were killed.

* Second Annual Report of the Bureau of Animal Industry (1885), p. 215.

ıe fourth rabbit (No. 350) was very sick, but evidently would have ed a few hours longer than the others. The number of colonies ıich developed in the gelatin roll cultures, made from the blood mediately after its defibrination, indicated that there were as many cteria present in the blood of these animals as there are in the blood rabbits which are allowed to die.

In this experiment with the sterilized blood young adult rabbits re used. The number of rabbits employed, quantity of blood injected, d the result of the test inoculation with hog-cholera bacteria are ven in the following table:

I.—*Tables showing the immunizing effect of sterilized blood of rabbits suffering from hog cholera.*

1. STERILIZED BLOOD INJECTED INTRAVENOUSLY.

rce of blood.	Rabbit No. 336.	Rabbit No. 310.	Rabbit No. 344.	Rabbit No. 344.	Rabbit No. 350.	Total amount in-jected.	Inoculated sub-cutaneously with 0.1 cc. of a bouillon cul-ture hog-cholera bacteria.	Results.
e of injec-on	Aug. 16.	Aug. 19.	Aug. 25.	Aug. 27.	Aug. 30.			
bit—	cc.	cc.	cc.	cc.	cc.	cc.		
No. 337	0.75	1.30	1.30	1	2.05	6.40	Sept. 3, 1892	Died Sept. 8, 1893.
No. 338	1	1.30	1.30	1	1.80	6.40	....do	Do.
No. 339	1.40	1.30	1.30	1	1.40	6.40	....do	Died Sept. 9, 1893.
No. 348	....	....	1	1.25	1.40	3.65	....do	Do.
No. 349	....	....	1	1.25	1.40	3.65	....do	Died Sept. 7, 1893.
No. 355	Check.	....	....	....	....	....	....do	Died Sept. 8, 1893.

2. STERILIZED BLOOD INJECTED SUBCUTANEOUSLY.

irce of blood.	Rabbit No. 336.	Rabbit No. 310.	Rabbit No. 344.	Rabbit No. 344.	Rabbit No. 350.	Total amount in-jected.	Inoculated sub-cutaneously with 0.1 cc. of a bouillon cul-ture hog cholera bacteria.	Results.
e of injec-on	Aug. 17.	Aug. 19.	Aug. 25.	Aug. 27.	Aug. 30.			
bit—	cc.	cc.	cc.	cc.	cc.	cc.		
No. 340	2.8	2.6	2.6	2	5	15	Sept. 3, 1893	Died Sept. 7, 1891.
No. 343	2.8	2.6	2.6	2	5	15	....do	Do.
No. 355	Check.	....	....	....	....	....	....do	Died Sept. 9, 1893.

At the same time a number of guinea-pigs were treated subcutane-sly with sterilized blood from the same rabbits. This experiment is mmarized in the subjoined table:

II.—*Table showing the immunizing effect on guinea-pigs of sterilized blood of rabbits suffering from hog cholera.*

irce of blood.	Rabbit No. 336.	Rabbit No. 310.	Rabbit No. 344.	Rabbit No. 344.	Rabbit No. 350.	Total amount in-jected.	Inoculated sub-cutaneously with 0.2 cc. bouillon culture of hog-cholera bacteria.	Results.
te of injec-ion	Aug. 16.	Aug. 19.	Aug. 25.	Aug. 27.	Aug. 30.			
inea-pig—	cc.	cc.	cc.	cc.	cc.	cc.		
No. 279	0.5	1.3	1.3	....	....	3.1	Sept. 3, 1893	Died Sept. 9.
No. 280	1	1.3	1.3	1	....	4.6	....do	Do
No. 272	....	....	....	1.25	1.4	2.65	....do	Died Sept. 10.
No. 283	....	....	....	1.25	1.4	2.65	....do	Do.
No. 288	Check.	....	....	....	....	....	....do	Do.
No. 289	...do	....	....	....	....	....	....do	Do.

It will be observed that even a slight degree of immunity was not produced. While the results differ from those obtained by Selander they are in conformity with those heretofore obtained in this laboratory with hog-cholera bacteria.

The toxic effect produced in the rabbits by the intravenous injection of the sterlized blood was very slight. The temperature rose from 1° to 1.8° F. after the first injection, but subsequently no elevation was detected. This was true of the subcutaneous injections in both rabbits and guinea-pigs. At no time did the animals refuse food, although they appeared to be unusually quiet for a short time after the first injection.

EXPERIMENTS WITH THE BLOOD SERUM OF RABBITS MADE INSUSCEPTIBLE TO FATAL DOSES OF HOG-CHOLERA BACILLI INTRODUCED UNDER THE SKIN.

These experiments were undertaken primarily to examine into the claims of Metchnikoff concerning the efficacy of blood serum from immune rabbits as a preventive and curative of hog cholera artificially induced in rabbits by inoculation.

In the course of these investigations a culture of the "hog-cholera" bacillus used by Metchnikoff in his work was asked for and kindly sent for examination. The study of this culture showed that Metchnikoff had not had the hog-cholera bacillus at all, but the swine-plague bacillus.* How this unfortunate mistake had come about it is not worth while to speculate upon here. It is sufficient to state that the persistence with which European observers have at first denied the existence of one or the other of these pathogenic forms and then confounded them, one with the other, is almost entirely responsible for the confusion which, from their point of view, exists in this subject.

The results obtained by Metchnikoff at first inexplicable are thus easily interpreted, and they agree entirely with the results detailed in

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*Metchnikoff kindly sent the blood of a guinea-pig inoculated with the bacteria in a sealed glass tube. Two of these tubes were examined and in both the same bacteria were found in a state of purity. Cultivated on various substrata they presented all the characters of swine-plague bacteria as found in this country. The bouillon growth is always feeble, the agar growth quite vigorous, forming a grayish membrane on the agar surface. In bouillon and on agar the bacteria appear as very minute cocci, having at times a marked dancing (Brownian?) motion utterly unlike the rapid spontaneous movement of hog-cholera bacilli. The characteristic polar stain so commonly seen in preparations from the tissues of rabbits is only rarely recognizable in cultures. On agar plates prepared in closed Petri dishes the colonies emit a peculiar, disagreeable odor very characteristic of the whole group of swine-plague bacteria. In tubes of gelatin or on plates development remains nearly always invisible to the eye. Milk remains unchanged. On potato there is no visible growth. In glucose bouillon gas is not set free.

The pathogenic action as shown on rabbits was equally peculiar to the swine-plague group.

November 22, 1892. Male rabbit, $2\frac{1}{16}$ pounds, was inoculated subcutaneously with two drops of blood from one of the original sealed pipettes.

November 26. Found dead. At site of inoculation there was a small area of puru-

s article, provided we substitute the words "swine-plague bacillus" erever he has used the words "hog-cholera bacillus." A description his experiments is therefore omitted here and given on page 74, ether with the work on the protective action of the blood serum of bbits made insusceptible to swine plague.

n our experiments blood serum from rabbits B, No. 205 and No. 232, s used. (*See* p. 43.)

The rabbits were secured and anæsthetized with chloroform or ether. arotid or a femoral artery was laid bare with proper aseptic precau- as and a sterile glass canula inserted. The blood was allowed to v into sterile pear-shaped glass bulbs and kept over night in a nperature of about 70° F. The clear serum was withdrawn with rile pipettes on the following day and kept in a refrigerator.

The following table summarizes the first experiment:

IX.—*Table showing immunizing efficiency of serum from rabbit B.*

d drawn ...	Dec. 2, 1892.*		Dec. 7.		Dec. 14.		Total quantity of serum injected.	Inoculation with 0.15 cc. virulent bouillon culture.	Result.
e of injec- on of serum.	Dec. 3.	Dec. 5.	Dec. 8.	Dec. 9.	Dec. 15.	Dec. 16.			
bit—	cc.	cc.	cc.	cc.	cc.	cc.	cc.		
No. 403.....	1.4	1.4	1.4	....	1.4	1.4	7	Dec. 29......	Dead Jan. 3.
No. 404.....	1.4	1.4	1.4	....	1.4	1.4	7	Dec. 29......	Do.
No. 378.....	....	....	1.4	1.4	1.4	1.4	5.6	Dec. 29......	Do.
No. 405 (control)	....	....	....	....	....	....	....	Dec. 29......	Do.
nea pig, 354.	1.4	1.4	1.4	....	1.4	1.4	7	Dec. 29......	Dead Jan. 13.

*Last inoculation with virulent culture September 15, 1892.

From this table it will be noted that there was no apppreciable ount of resistance acquired by the rabbits during the treatment h blood serum. The guinea-pig lived about eight days longer than usual period. Unfortunately no control was used with this animal the use of the guinea-pig was rather an after-thought in this experi- nt. It is not necessary to give the autopsy notes of these animals, they present nothing unusual.

t infiltration with surrounding hemorrhages and ecchymoses. Extravasations on entum and on lower portion of large intestine. Spleen large, dark, and firm. In lung 5 small hemorrhagic foci. In stained cover-glass preparations of spleen p a large number of bacteria showing the polar stain very well. In heart's od very few. Cultures from blood and spleen positive.

anuary 10, 1893. A rabbit received into an ear vein 0.12 cc. of a bouillon culture enty-four hours old. This culture was derived from the blood in the sealed pipette ough agar plates and agar subcultures from a colony. The rabbit was found d next morning with hyperæmic lungs and punctiform ecchymoses under serosa large intestine. Immense numbers of polar-stained bacteria in the spleen. This ganism has been kept growing up to the present with no change in its characters ond a gradual decline of virulence.

The following table summarizes a later experiment with the serum of rabbits Nos. 205 and 232:

X.—*Table showing immunizing efficiency of serum from rabbits 205 and 232.*

Blood from	No. 205.*		No. 232.†		No. 205.		Total quantity of serum injected.	Inoculation with virulent bouillon culture Feb. 13.	Results.
When drawn	Jan. 4, 1893.		Jan. 11.		Jan. 23.				
Date of injection of serum	Jan. 5.	Jan. 6.	Jan. 12.	Jan. 13.	Jan. 25.	Jan. 28.			
	cc.	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	
Rabbit—									
No. 416	1.3	1	1	1.4	1.4	0.5	6.6	0.06	Dead Feb. 18.
No. 413	1.3	1	1	1.4	1.4	0.5	6.6	0.06	Do.
No. 415 (control)	....	....	....	....	....	....	....	0.06	Dead Feb. 20.
Guinea pig—									
No. 365	1.3	0.75	1	1.4	1.4	....	5.85	0.09	Dead Feb. 22
No. 366	1.3	....	1	1.4	1.4	....	5.1	0.09	Dead Feb. 20.
No. 367 (control)	....	....	....	....	....	....	....	0.09	Do.
No. 369 (control)	....	....	....	....	....	....	....	0.09	Dies Feb. 20 (noon).

*Last inoculation with virulent culture of hog-cholera bacilli was made September 15, 1892.
†Last inoculation July 29, 1892.
The guinea-pigs weighed about 1.5 pounds, the rabbits 3 to 3.5 pounds.

In connection with the blood-serum injections a curious effect on the guinea-pigs was noticed. In No. 365 a bluish discoloration 1 to 1½ inches in diameter appeared at the place of injection (abdomen), with more or less firm infiltration in the subcutaneous tissue. At the time of the test inoculation the lesion had disappeared.

In No. 366 a similar infiltration, without discoloration, appeared after two injections, one of which became ulcerated. This also had healed February 13.

When first observed it was suspected that perhaps a few hog-cholera bacilli had been in the animals from which the serum was drawn. This supposition was disposed of by the fact that no infiltration or reaction of any kind followed the injection in the more susceptible rabbits. To what other causes this phenomenon may be referred to, inquiries have not yet been made. It may have been due either to the irritating action of the rabbit's serum *per se* or to some change in the serum brought about by the acquired immunity.

This experiment may be objected to, as illustrating the absence of any protective substance in the blood in appreciable quantity, on two grounds—the long interval between the drawing of the blood and the last virulent inoculation, and the long interval between the last blood-serum injection and the test inoculation (sixteen days). These objections are to a certain extent well founded. There were, however, sufficient reasons for the delay. The hog-cholera bacillus is not eliminated from the organs of immune rabbits for *at least* a month after inoculation and it probably persists much longer. Hence any haste in the collection of the blood may either miss the period of maximum protective power or it may lead to the collection of blood containing living

g-cholera bacilli. The test inoculation following the blood-serum atment was delayed to give the indurations and ulcers produced by blood serum in guinea-pigs sufficient time to heal.

The absence of any retarding effect of the blood serum on the disease rabbits under the conditions of the experiment shows that any preciable increase of resisting power is not likely to be obtained by reasing the quantity of the serum. This result is in entire accord h the negative outcome of the other immunizing methods applied to bbits. With guinea-pigs the result is somewhat different. There ms to have been a slight degree of immunity induced in the guinea-; used in the first blood-serum experiment. This also is in accord h the sterile-bouillon experiment and the blood-serum experiment guinea-pigs, described below.

ES THE BLOOD OF IMMUNE RABBITS POSSESS ANY BACTERICIDE OR ANTITOXIC POWER?

Only one trial was made. Some preliminary experiments carried out Dr. C. F. Dawson in this laboratory had shown the absence of any tericide action of the blood serum of immune rabbits on hog-cholera illi. The blood serum used by him was obtained from one or the ier of the rabbits Nos. 205, 232, and B.

n January of 1894, rabbit B was killed and a small quantity of od-serum obtained, which was used as follows:

A definite quantity of a bouillon culture of hog-cholera bacilli, enty-four hours old, was added by means of a carefully graduated p pipette to a definite quantity of serum and the mixture injected o rabbits subcutaneously after a certain length of time, as indicated the subjoined table:

—*Table showing results of injection of rabbits with mixture of hog-cholera bacilli and serum.*

Rabbit.	Serum mixture contains— Of bouillon culture of hog-cholera bacilli.	Serum.	Time elapsing between mixing serum and bacilli and inoculation into rabbit.	Date of inoculation.	Result.
	cc.	cc.	Hrs. min.		
127	.033	0.5	0 15	Jan. 10, 1894	Dead January 17.
128	.033	0.5	1 48	....do	Dies January 15, noon.
126	.033	0.5	24 00	Jan. 11, 1894	Dies January 16.
84	.033	*0.5		Jan. 10, 1894	Dies January 13.

* Sterile bouillon.

The cause of death in these animals was determined by a careful topsy, by cultures and by the examination of cover-glass preparations the spleen pulp. There seems to have been a slight retardation of ath in favor of the fifteen-minute serum mixture. However, the riod of the disease produced by it was within the normal limit, while

that of the control rabbit was shorter than is usually the case. Any protective action of the serum mixture can not be deduced. It should be stated that the rabbit furnishing the serum had not been inoculated with hog-cholera bacilli since September 15, 1892.

EXPERIMENT ON GUINEA-PIGS WITH BLOOD SERUM FROM GUINEA-PIGS IMMUNIZED AGAINST HOG-CHOLERA BACTERIA.

A single experiment was made on guinea-pigs to test the immunizing efficacy of the blood serum from guinea-pigs previously made immune to hog cholera by artificial means. The method of immunizing the animals from which to obtain the serum was the subcutaneous injection of sterilized bouillon culture of hog-cholera bacteria. A detailed account of the immunization of these guinea-pigs is given on p. 50, under the numbers 474, 473, and 453. No. 453 had been inoculated twice with hog-cholera bacteria, the other two once only.

Guinea-pig No. 474 was bled twenty-four days after the test inoculation and seventeen days after the control guinea-pig had died.

Guinea-pig No. 473 was bled thirty-seven days after the test inoculation and thirty-one days after the control had died.

Guinea-pig No. 453 was bled thirty-eight days after the second test inoculation and thirty-two days after the death of the control animal.

At the time the guinea-pigs were bled they were in excellent condition. After they had been bled and killed a careful examination showed that they were free from any lesions of disease. As a precautionary measure, however, tubes of bouillon were inoculated with several large loops of the blood and with a large piece of the spleen of each animal. Stained cover-glass preparations from the various organs showed no bacteria. The tubes of bouillon inoculated with the blood remained clear, but those inoculated with the spleen developed into pure cultures of hog-cholera bacteria on the second day. One rabbit was inoculated with each of these cultures. All died of hog cholera in the usual time.

The length of time during which the hog-cholera bacteria remained alive in the spleen of these animals and the unchanged virulence are facts worthy of notice. The permanent sterility of the bouillon tubes inoculated with the blood would indicate that the bacteria were not present in this fluid at the time the guinea-pigs were killed, and that the serum used was free from living bacteria.

To obtain the blood from the immune guinea-pigs the animals were etherized, the hair removed from the neck, and the skin thoroughly disinfected. The carotid artery was then exposed with sterile instruments and the animal held in such a position that the blood from the incised artery could run into a sterile funnel and thence into a sterilized pear-shaped glass bulb. About 25 cc. of blood was obtained from each animal. This was placed in a temperature of about 8° C. From 4 to 7 cc. of clear serum was obtained from each animal. The injection

'guinea-pigs with the serum, the subsequent test inoculation, and its sult are summarized in the subjoined table:

I.—*Table showing immunizing effect of blood serum from immune guinea-pigs injected subcutaneously.*

urce of se-rum.	Guinea-pig—No. 474.	Guinea-pig—No. 474.	Guinea-pig—No. 473.	Guinea-pig—No. 473.	Guinea-pig—No. 453.	Total quantity of serum injected.	Inoculated with 0.1 cc. bouillon culture of hog-cholera bacteria.	Results.
te of injec-ion.	Oct. 20, 1893.	Oct. 25, 1893.	Nov. 2, 1893.	Nov. 6, 1893.	Nov. 9, 1893.			
inea-pig—	cc.	cc.	cc.	cc.	cc.	cc.		
No. 1	1	1	1	1	2	6	Nov. 13, 1893	Died Nov. 27, 1893.
No. 4	1	1	1	1	2	6	....do	Died Dec. 7, 1893.
No. 2				1.5	3	4.5	....do	Died Nov. 24, 1893.
No. 5					2	2	....do	Do.
No. 8						check	....do	Do.

The results obtained in this experiment are more positive than those tained by the use of sterilized rabbit's blood. While the injection 2 cc. of the serum produced no effect the, use of 6 cc. produced an preciable resistance. The large number of tubercle-like bodies found guinea-pig No. 2 may be taken as an indication of partial immunity, though it died with the check. No. 4 survived the inoculation for enty-four days. The amount of resistance induced by the blood rum was no greater in proportion to the quantity used than that tained with the agar cultures sterilized by heat.

SWINE PLAGUE

The swine-plague bacteria used in this series of experiments are scribed in the Special Report on the Cause and Prevention of vine Plague, Department of Agriculture, 1891 (p. 57). They were fficiently virulent to destroy rabbits inoculated subcutaneously with)01 cc. of a fresh bouillon culture in less than twenty hours. The llowing experiments are similar in detail to those made with hog-olera bacteria.

(PERIMENTS WITH STERILIZED BOUILLON CULTURES OF SWINE-PLAGUE BACTERIA.

In these experiments young adult rabbits were used. The sterilized uillon cultures were prepared and test inoculations were made in cordance with the methods given in the hog-cholera experiments. ntrol rabbits were always used. These died without exception thin twenty-four hours. On this account they are omitted from the ble giving the details of the treated rabbits.

The immediate, toxic effect of the injection of the sterilized bouillon ltures varied according to the method of injection. The rabbits that ceived the cultures in the peritoneal cavity sat very quietly for a few urs, but otherwise they appeared to be well. The intravenous injec-n produced a more marked depression. The animals sat in a crouched sition, refused food, and offered no resistance to handling. The

temperature rose 1 to 1.5° F. Usually the effect was noticeable for about twenty-four hours, after which time the animals appeared to be in their normal condition. These well-marked disturbances occurred after the first injection only. Subsequent injections produced very little and often no appreciable effect. A summary of the facts in this experiment is given in the following table:

XIII.—*Table showing results of experiments with sterilized bouillon cultures of swine-plague bacteria.*

Rabbit—	Date of first injection.	Method of injection.	Total quantity of steril-ized culture injected.	Number of injections.	Test inoculation with living swine-plague bacteria.	Results.
			cc.			
No. 12....	Dec. 26, 1890	Ear vein...	7	5	Jan. 16, 1891	Died Jan. 19. Severe local reaction and peritonitis.
No. 13....	Jan. 26, 1891	....do	7	5	Feb. 24, 1891	Died Feb. 26.
No. 14....	Apr. 24, 1891	....do	8	3	May 19, 1891	Died May 20.
No. 15....	....do	....do	12	4	May 26, 1891	Died June 3. Severe local reaction, pleuritis, and peritonitis.
No. 16....	....do	....do	16	5	June 5, 1891	Died June 11, 1892. Very slight local reaction, which healed; large closed abscess in abdominal cavity.
No. 17....	....do	....do	16	5	....do	Recovered. Killed for examination Mar. 24 1892.
No. 18....	Mar. 10, 1891	Abdominal cavity.	20	4	Mar. 31, 1891	Died Apr. 1.
No. 19....	....do	....do	20	4	....do	Do.
No. 20....	....do	....do	40	8	Apr. 17, 1891	Died Apr. 18.
No. 21....	....do	....do	40	8	....do	Recovered. Severe local reaction. Killed for examination Feb. 9, 1892.

The foregoing table shows that the injection of the sterilized cultures into the veins produced a greater degree of resistance than the injection into the abdominal cavity. It will be found from the appended post-mortem notes that the degree of resistance on the part of the treated animal was accompanied by variations in the course of the disease, so that when a rabbit resisted the inoculation of virulent swine-plague bacteria for a number of days it exhibited lesions similar to those found in rabbits that died from an inoculation of an attenuated swine-plague germ which required several days to destroy life. These variations are especially well marked in rabbits Nos. 12 and 15. The effect of the inoculation in rabbit No. 16 is of special interest, as the animal showed no disturbance for several months after the inoculation. but died more than a year later. This variation in the course of the disease will be more fully illustrated in the experiments with agar cultures. The interesting points in the post-mortem notes of these rabbits are appended. Attention is particularly called to those of rabbits Nos. 12, 15, and 16.

Rabbit No. 12 lived three days after inoculation. There was quite a severe purulent infiltration at the place of inoculation. Surrounding this the blood vessels were much injected; about 4 cm. from the point of inoculation toward the knee-

ld a small mass of purulent substance. On the cæcum a small quantity of a ayish, pasty exudate was collected into bands and shreds which contain leuco- tes and an innumerable number of swine-plague bacteria. Under the serosa of ie small intestine, excepting duodenum, are numerous blood extravasations of regular outline. Lungs œdematous and partially collapsed. A large number of lar-stained bacteria in preparations from the spleen and blood. A cover-glass uched to the pleura on the diaphragm and stained showed a few swine-plague icteria.

Rabbits Nos. 13 and 14 died within forty-eight and twenty-four hours of acute vine plague.

Rabbit No. 15 lived eight days. At the point of inoculation the subcutis was infil- ated with a purulent exudate extending over an area 6 cm. in diameter; subjacent uscles necrosed; surrounding blood vessels injected. Over intestines were a few ne shreds of exudate. Liver hyperæmic. Spleen very dark. Kidneys pale. Right ing hyperæmic; pleura, both parietal and visceral, covered with a thin cellular kudate. In cephalic lobe two foci about 1 cc. in diameter in a state of gray- h consolidation. The left pleural cavity lined with a quite thick membranous xudate which covers the entire surface of the lung. On the dorsal surface of the rincipal lobe an area 2 cm. in diameter and extending through the lung was consoli- ated, of a yellowish-gray color, apparently necrosed; the remaining portion of ie principal lobe hyperæmic; cephalic lobe collapsed. Pericardium covered with thin cellular exudate. Heart muscle pale. The exudate contained an innumerable umber of swine-plague bacteria. Very few bacteria in cover-glass preparations rom the spleen.

Rabbit No. 16 lived one year and six days after inoculation. This rabbit appeared o be perfectly well for several months after the inoculation. In the spring of 1892 t was observed to be emaciated to a considerable degree. It died June 11, 1892. he post-mortem examination showed the rabbit to be very poor. The abdominal avity contained a very large tumor extending from the pubes cephalad and cover- ng the kidneys and crowding the intestines up under the ribs. The cæcum was ying over the stomach. The tumor was found to be beneath the peritoneum, the lood vessels of which were injected. The ovaries, Fallopian tubes, ureters, and ectum were plainly visible on the convex surface of the tumor. An incision showed he tumor to consist of an outer rather firm wall about 2 mm. thick, containing a vhitish substance resembling fine wheat-flour paste in consistency. A microscopical xamination showed it to consist of broken-down pus cells and fine granules. The umor when removed weighed 900 grams or nearly one-half the entire weight of the nimal (total weight 1,980 grams). The liver, spleen, and kidneys were small and irm. Heart and lungs apparently normal. A tube of bouillon was inoculated and series of agar plate cultures made from the contents of the tumor. These devel- oped into pure cultures of swine-plague bacteria. The virulence of the germ was ested on rabbits with the following results:

June 15. *Rabbit No. 286* was inoculated subcutaneously with 0.30 cc. of a bouillon ulture. June 18, rabbit found dead with lesions characteristic of attenuated swine plague, i. e., severe local infiltration and peritonitis.

June 30. *Rabbit No. 316* was inoculated subcutaneously with 0.25 cc. of a bouillon ulture made from the blood of rabbit No. 286. July 1, rabbit found dead. Innu- merable swine-plague bacteria in the organs.

July 2. *Rabbit No. 315* was inoculated subcutaneously with 0.01 cc. of a bouillon culture from rabbit No. 316. It died within twenty-four hours.

These inoculations were sufficient to restore the virulence of the bacteria inocu- lated into rabbit No. 16, and to demonstrate the identity of the bacteria obtained from the closed abscess with the bacteria inoculated a year previously.

Rabbit No. 17. This animal was killed for examination March 24, 1892. It was found in good condition. No bacteria were found either in cover-glass preparations or in cultures from the organs.

Rabbits Nos. 18, 19, and 20 died from the acute, septicæmic form of swine plague.

Rabbit No. 21, killed February 9, 1892, nearly ten months after its inoculation. Very much emaciated. Beneath the skin over abdomen several small cysts containing pus. Projecting into abdominal cavity from the dorsal wall is a tumor about 8 cm. in diameter. Upon inspection it was found to consist of a grayish, pasty, purulent substance inclosed in a sac having a wall about 2 mm. in thickness. A tube of agar inoculated with a loop of the heart's blood remained clear. A tube of bouillon inoculated from the contents of the tumor developed into a pure culture of swine-plague bacteria. A rabbit inoculated subcutaneously with 0.25 cc. of this culture died within twenty-four hours.

EXPERIMENTS WITH STERILIZED SUSPENSIONS OF AGAR CULTURES OF SWINE-PLAGUE BACTERIA.

In the preparation of the suspensions of the agar culture the same method was pursued as in the hog-cholera experiments. The cultures varied in age from two to five days. The surface growth was diluted with bouillon and filtered through sterilized Japanese filter paper, to remove all masses of agar and clumps of bacteria. The filtrate had a grayish, turbid appearance. The suspension was distributed in large sterile test tubes, closed with cotton plugs and sterilized by heating in a water bath for one hour at 60° C. The sterility of the heated cultures was determined by means of subinoculations in bouillon. Control rabbits were used in all experiments, but are omitted from the table. As in the preceding experiment, they invariably succumbed to the subcutaneous inoculation within twenty-four hours. The rabbits used in the experiment were young adults. The details of this experiment are given in the following table:

XIV.—*Table showing results of experiments with sterilized suspensions of agar cultures of swine-plague bacteria.*

Rabbit—	Date of first injection.	Method of injection.	Total quantity of sterilized suspension used.	Number of injections into which it was divided.	Inoculated with living swine-plague bacteria.	Results.
			cc.			
No. 38	May 4, 1891	Abdominal cavity.	4.5	3	May 19, 1891	Died May 25, 6 days after inoculation.
No. 35	do	do	7.5	4	May 26, 1891	Died Feb. 2, 1892, 9 months after inoculation.
No. 37	do	do	7.5	4	do	Recovered.
No. 36	do	do	7.5	4	do	Do.
No. 51	June 9, 1891	do	3	2	June 19, 1891	Died June 22, 3 days after inoculation.
No. 50	do	do	3.5	3	June 29, 1891	Recovered.
No. 52	do	do	12	4	do	Do.
No. 53	do	do	12	4	do	Do.
No. 23	do	Ear vein	1.5	2	June 19, 1891	Do.
No. 54	do	do	2	3	June 29, 1891	Do.
No. 76	June 29, 1891	do	2.5	3	July 7, 1891	Died July 8, with control rabbit.
No. 77	do	do	2.5	3	do	Do.
No. 130	Oct. 1, 1891	do	2	1		Died Oct. 2, from the effect of treatment.
No. 129	do	do	3.5	3	Oct. 15, 1891	Died Nov. 4, 20 days after its inoculation.
No. 152	Oct. 16, 1891	do	5.5	3	Nov. 19, 1891	Recovered.
No. 79	June 29, 1891	Subcutis	4	3	July 7, 1891	Died July 8, with control rabbit.
No. 78	do	do	8.5	5	July 18, 1891	Recovered.

The injections of sterilized suspension of swine-plague bacteria were)eated at intervals of from two to six days according to the effect)duced. Time was allowed for the normal condition of the animal become restored after each injection before the latter was repeated. case of the intravenous injection this period was much longer than the other cases. The test inoculation was made in from two to six ys after the last injection.

The immediate or toxic effect of the agar suspension was more severe n that produced by the bouillon culture. The abdominal injection s followed by a slight indifference on the part of the rabbits when ndled and their refusal of food. The intravenous injection, however,)duced a marked effect. There was an elevation of the temperature from 0.5° to 2° F. within two hours. Respiration accelerated. Eyes ually more or less closed. In from twelve to eighteen hours the nperature reached 104.5° to 105.6° F. which elevation continued for out twenty-four hours, when it rapidly subsided to the normal. Dur- this time the rabbits refused food, offered no resistance to handling, l the fur had a ruffled appearance. In some cases the injection was lowed within twenty minutes by a copious evacuation of the bowels. bsequently the rabbits appeared to suffer from tenesmus for a shorter longer time. The second injection produced the same symptoms. ter the third injection the reaction was very slight and often inap- ·ciable.

The subcutaneous injections produced no appreciable constitutional nptoms. There was a slight infiltration of the subcutis at the points injection which disappeared in a few days.

t is of interest to note that in rabbits Nos. 38 and 51 which received all quantities of the suspension there was very severe local reaction er the inoculation with the strong virus followed by peritonitis and th. In No. 50 there was severe local reaction with recovery. In se that received 7.5 cc. the local reaction was less severe and recovery owed in two of the three cases. No. 35 is extremely interesting m the fact that the rabbit lived nearly ten months. In the two rab- s which received 12 cc. each, there was scarcely any local reaction l the animals remained apparently perfectly well.

t is difficult to understand the effect of the intravenous injections. bbits Nos. 23 and 54 resisted the inoculation of the strong virus, ough they had received only a small quantity of the suspension, ile Nos. 78 and 79 offered no resistance, although they had received reater quantity. The subcutaneous injection of the agar suspen- n was equal to the abdominal injection in efficiency. The rabbits it perished after showing a marked resistance were affected with ions that are of sufficient interest to be briefly recorded:

abbit No. 38 resisted sixty days. A purulent infiltration at point of inoculation r an area 3 cm. in diameter; subjacent muscle pale. Spleen slightly enlarged. er congested. The pleura of both lungs and parietes covered with a grayish

friable exudate consisting of cells and bacteria. Exudative pericarditis. Lungs deeply hyperæmic, only partially collapsed.

Rabbit No. 51 resisted three days. A purulent infiltration in the subcutis at point of inoculation over an area of about 2 cm. in diameter. Over abdominal viscera a grayish exudate composed of round cells and swine-plague bacteria.

Rabbit No. 35 resisted for nearly nine months. Rabbit very much emaciated. At point of inoculation a closed abscess about the size of a horse-chestnut, containing pus of a pasty consistency. Thoracic and abdominal organs pale; brain and spinal cord apparently normal. Culture media inoculated from the local abscess and blood remained clear. The time which had elapsed (nearly ten months) after the inoculation was sufficiently long to admit of other causes, but it seems more likely on account of the local abscess that the swine-plague inoculation was primarily responsible.

Rabbit No. 129 resisted twenty days. It exhibited a small abscess at the point of inoculation. The abdominal cavity contained considerable clear serum. The heart and lungs were encased in a thick layer of purulent substance containing innumerable swine-plague bacteria. Lungs nearly collapsed; no hepatization.

Rabbit No. 130 died from the effect of an injection of 2 cc. of the sterilized emulsion. In cæcum several punctiform hemorrhages. Liver and kidneys were hyperæmic. The spleen was congested and somewhat enlarged. On the pleural side of the diaphragm were several punctiform hemorrhages; they were also present in the meninges of the spinal cord and in the subcutis over the cranium. No peritonitis or pleuritis. No swine-plague bacteria in cultures from the organs.

Rabbit No. 50 was killed February 25, 1892, nearly eight months after inoculation. On abdomen, at point of inoculation, there was an open abscess about 3 cm. in diameter. Its contents were of a grayish, pasty consistency. Otherwise the animal was in excellent condition. As the abscess was open no cultures were made from it.

Rabbit No. 53 was killed February 18, 1892, nearly eight months after inoculation. Rabbit in excellent condition. Beneath the skin over the abdomen there were two small abscesses; one about the size of a small walnut had ruptured, the other was about 3 cm. long and 1 cm. in diameter. It contained a pasty, yellowish, purulent substance. An examination showed only pus cells and degenerated cell substance. A tube of bouillon inoculated with a loop of the contents remained clear.

Rabbit No. 52 was killed February 12, 1892, seven and one-half months after inoculation. Rabbit in a well-nourished condition. At the point of inoculation on the side of the abdomen there was an abscess 8 by 3 cm., composed of a considerable number of small cysts which were found to communicate with each other. The contents consisted of a thick, pasty material composed of pus cells in a state of fatty degeneration. Lungs congested, hypostatic. Heart muscle pale, otherwise normal. A tube of bouillon inoculated with the blood remained clear. One inoculated from the contents of the abscess developed into a pure culture of the swine-plague germ, whose virulence was tested as follows:

February 18, a rabbit was inoculated subcutaneously with 0.2 cc. of the bouillon culture from rabbit No. 52. February 25, rabbit was found dead. Extensive purulent infiltration into the subcutis and inter-muscular tissue extending over an area 9 cm. in diameter, agglutinating the thigh to the abdominal wall. Cephalic lobes of both lungs in a state of gray hepatization containing small abscesses. A pure culture of the swine-plague germ was obtained from the spleen.

Rabbit No. 36 chloroformed February 15, 1892, eight and one-half months after its inoculation. Rabbit in a well-nourished condition. On the thorax there was an abscess about the size of a hen's egg which had ruptured. Surrounding this were several encysted abscesses varying from 0.5 to 2 cm. in diameter containing a thick pasty, purulent substance. These did not appear to have any communication with each other or with the ruptured abscess. Otherwise the rabbit was apparently normal. A tube of bouillon inoculated with a bit of the contents of one of the

sts developed into a pure culture of the swine-plague bacillus. On February 18, rabbit was inoculated subcutaneously in the thigh with 0.2 cc. of this bouillon ulture. It was found dead on the following morning. Innumerable swine-plague acteria were found in stained cover-glass preparations from the various organs.

The remaining animals, which showed no external lesions or sympoms of disease after a few months, were used for other purposes.

The presence of swine-plague bacteria in the subcutaneous abscesses f rabbits Nos. 52 and 36 is a further illustration of the long period of me during which these organisms will remain alive in the lesions which ney produce. Attention is called to the attenuated condition of the acteria obtained from rabbit No. 52 and to the virulence of those isoted from a similar abscess in rabbit No. 36.

Although the rabbits killed for examination exhibited no lesions hich presumably would not have been overcome had the animal been ermitted to live, the fact remains that they were not made totally isusceptible to the action of the virulent bacteria. Here again is an lustration of the dangers of vaccination, for although the rabbits surived, they could not be considered as safe companions for other susptible animals so long as they harbored the virus of the disease in bscesses which were liable to rupture at any time.

EXPERIMENTS WITH THE FILTRATE OF AGAR SUSPENSIONS.

The successful production of immunity in rabbits with sterilized urbid suspensions of swine-plague bacilli grown on the surface of utrient agar made it desirable to test the immunizing properties of ne bouillon in which these bacilli had been suspended for several ours and then removed by filtration. Such an experiment would nform us how far the bodies of the bacteria themselves, or any subtance derived from them and passing promptly into solution in the uspending fluid, would be responsible for the immunizing action.

The suspensions from agar cultures were prepared as already escribed and placed in an incubator for twenty-four hours. They ere then sterilized by heat as before and filtered through a Pasteur ougie, which removed all of the bacteria. The filtrate was perfectly lear and of a dark amber color.

Four rabbits were injected intravenously with the filtrate. Two of hem received 3 cc. in three injections of 1 cc. each, and one received 3 cc. n two injections, and one received 4 cc. in three injections. They were ubsequently inoculated with virulent swine-plague bacteria. They lied in less than twenty-four hours with the control animals.

The injection of the filtrate was followed by a slight elevation of emperature and general depression, which was of much shorter duraion than that produced by the suspension. A control experiment howed that similar symptoms were developed by the injection of an qual quantity of sterilized bouillon or normal salt solution.

EXPERIMENTS WITH DEFIBRINATED, STERILIZED BLOOD OF RABBITS AFFECTED WITH SWINE PLAGUE.

The culture of swine-plague bacteria used in the preceding experiments was also used here. It was fatal to rabbits twenty hours after inoculation.

The blood was obtained as follows: A rabbit was inoculated with a very small dose of swine-plague bacteria late in the afternoon, and on the following day it was watched very carefully, and just before death would have ensued the animal was etherized and the blood drawn by means of a slender sterilized glass canula inserted into the carotid artery. The blood was collected in large sterile tubes and defibrinated. It was then heated in a water bath for thirty minutes at a temperature of 58° C. Agar tubes were inoculated with the blood before and after the heating. The cultures made from the blood before it was heated showed the swine-plague bacteria to be present in large numbers. Those made after the heating remained invariably clear. The sterilized blood was kept at a temperature of about 8° C. until it was needed for use, when the desired quantity was heated up to the body temperature.

A.—EXPERIMENTS ON RABBITS.

In these experiments the sterilized blood was injected subcutaneously and into an ear vein. The number of injections made, quantity of sterilized blood used, and the results obtained after the test inoculation with the living bacteria are given in the following table:

XV.—*Table showing results of experiments with rabbits treated with sterilized blood of swine-plague rabbits.*

Date of blood injection.	Mar. 24.	Mar. 28.	Apr. 4.	Apr. 7.	Apr. 10.	Total.	Inoculated with swine-plague bacteria—	Results.
Subcutaneous.								
Rabbit—	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*		
No. 441	1.5	1.5	3	3	3	12	Apr. 19, 1893	Recovered.
No. 446	1.5	1.5	3	3	3	12	....do	Do.
No. 443	1.5	1.5	1.5	1.5	....	6	....do	Do.
No. 442	....	1.5	1.5	3	....	6	....do	Died June 14, pleuritis and pericarditis.
No. 485 (control)	....	....	....	....	....	....	....do	Died April 20, acute swine plague.
Intravenous.								
Rabbit—								
No. 439	1	1.5	1.5	....	....	4	Apr. 8, 1893	Recovered.
No. 440	1	1.5	1.5	....	....	4	....do	Do.
No. 444 (control)	....	....	....	....	....	....	....do	Died Apr. 9.

The immediate effect produced by the injection of the sterilized blood was manifested by a considerable rise of temperature in about three hours after the injection. It soon subsided, however, and no other

ymptoms were detected. This was true of the rabbits that were injected oth intravenously and beneath the skin. The temperature of the eated rabbits was normal at the time the control animals died. For everal weeks these rabbits appeared entirely well. It was then observed at subcutaneous abscesses were forming on different parts of the body. early two months after the check died rabbit No. 442 was found dead. he post-mortem notes of this animal are as follows:

June 14, rabbit No. 442 found dead. It was somewhat emaciated. The abdominal gans were not appreciably diseased. The pleural cavity contained a large quantity serum, and the pleura (visceral and parietal) was covered with a thick exudate, e deeper layer of which was firmly adherent to it. The heart was incased in a ther thick membranous exudate. Heart muscle pale; blood dark but not clotted. over-glass preparations from the exudate contained a considerable number of polar-ained swine-plague bacteria. A tube of bouillon inoculated with the exudate veloped a pure culture of swine-plague bacteria.

June 15, rabbit No. 443 was chloroformed. The post-mortem examination showed slight thickening of the subcutaneous tissue at the point of inoculation. The oracic and abdominal organs were apparently in a normal condition. No swine-ague bacteria were found in the organs or in the subcutaneous tissue at the point inoculation.

June 30, 1893. The abscesses beneath the skin of rabbits Nos. 441, 446, 439, and 440 ere found to vary from 1 to 4 cm. in diameter. None of them were located at the int of inoculation. Their distribution is best illustrated by referring to No. 439. is rabbit had an abscess, which had ruptured, over the sternum, an abscess as large an English walnut in the subcutaneous tissue on the right side of the thorax, e beneath the superficial muscle over the right thigh, and one small abscess neath the skin in the right popliteal space. The abscesses were opened in rabbits os. 439 and 448 and found to contain a thick, somewhat viscid, grayish, purulent bstance. Tubes of bouillon inoculated from this purulent substance developed to pure cultures of swine-plague bacteria. This localization of the bacteria did t appear to affect the general health of the rabbits. After the abscesses were ened they healed with one exception (one abscess in rabbit No. 439), and the bbits appeared to be perfectly well. In order to determine whether or not the scesses were confined to the subcutaneous tissue, these rabbits (Nos. 439 and 440) re chloroformed July 14, and thoroughly examined. No. 439 showed no lesions, t in No. 440 two of the axillary glands were enlarged and found to contain i of suppuration, and beneath the peritoneum in the lumbar region there was an scess containing broken-down pus cells and swine-plague bacteria, as determined microscopical examination. The kidneys were small and firm but free from cteria, as indicated by cultures. Nos. 441 and 446 were inoculated twice subse-uently with a culture of the same virulent swine-plague bacteria without manifest-g any general disturbances. For their further history and use see p. 74.

B.—Experiments on Guinea-Pigs.

A single experiment was made on guinea-pigs with the sterilized ood from the swine-plague rabbits. Two guinea-pigs, Nos. 374 and 7, received subcutaneously 5.25 cc. each of the sterilized blood in 3 ses (March 28, April 4, and April 7). April 18 they were inoculated bcutaneously, together with two control guinea-pigs, with 0.01 cc. ch of a fresh bouillon culture of swine-plague bacteria. The check

died in six days. The treated animals remained apparently perfectly well. They were subsequently used for other purposes, but on post-mortem examination they did not reveal the existence of any lesions that could be attributed to the swine-plague bacteria previously inoculated.

GUINEA-PIGS MADE INSUSCEPTIBLE TO SWINE-PLAGUE BACTERIA OFFER NO RESISTANCE TO HOG-CHOLERA BACTERIA, AND VICE VERSA.

The difference that exists between the products of hog-cholera and swine-plague bacteria, as shown by the foregoing experiment, is further illustrated by the fact that guinea-pigs that are immune to one disease offer no resistance to the other. From the differences already pointed out between these two species of bacteria this condition would be expected, and consequently only one experiment has been made with each.

Guinea-pigs Nos. 1 and 2, that had been immunized against hog cholera by subcutaneous injections of sterilized bouillon cultures, were inoculated with 0.01 cc. of a bouillon culture of virulent swine-plague bacteria. They died on the third day with the control animal. One of these guinea-pigs (No. 2) had been twice inoculated with hog-cholera bacteria.

Guinea-pigs Nos. 374 and 377 were made resistant to the fatal effect of swine-plague bacteria by subcutaneous injections of sterilized defibrinated blood from swine-plague rabbits. They were subsequently inoculated with 0.1 cc. of a bouillon culture of virulent hog-cholera bacteria. They lived one and two days respectively longer than the control, which died in an unusually short time. The lesions found upon examination were those characteristic of acute hog cholera. The variations found to exist in the length of time required for 0.1 cc. of a bouillon culture of hog-cholera bacteria to kill guinea-pigs render the short time these animals lived after the control died of no significance, especially as there were no variations in the lesions to indicate increased resistance.

PROTECTIVE ACTION OF BLOOD SERUM FROM IMMUNE RABBITS.

According to Metchnikoff a comparatively small quantity of blood serum from immunized animals is sufficient to induce immunity in rabbits. It will be remembered that while he asserts this for hog-cholera bacilli he was actually working with swine-plague bacteria. As small a quantity as 0.5 cc. of serum from immunized rabbits injected subcutaneously was sufficient to protect a rabbit from a quantity of virulent blood sufficient to kill a control rabbit. Injection of serum into the circulation directly was much less efficacious.

The following experiment fully confirms Metchnikoff's work if, as has

een stated above, we substitute the words swine plague for hog cholera his article. The serum was obtained from rabbits Nos. 441 and 446 ade immune with sterilized defibrinated blood of rabbits affected ith swine plague and referred to on page 72.

These rabbits were reinoculated with swine-plague bacteria as follows:

June 24, 1893. Nos. 441, 446, and a control receive subcutaneously 0.12 cc. of a uillon culture three days old.

June 25. Control dead this morning. The others apparently unaffected.

December 5, 1893. Nos. 441, 446, and a control received subcutaneously 0.12 cc. of a uillon culture (the same stock culture) twenty-four hours old.

December 6. Control dead.

December 7. No. 441 has a temperature of 102° F.; No. 446, 101° F.

December 12. No. 441 has a temperature of 102° F.; No. 446, 101.4° F.

No. 446 was etherized and bled from a carotid January 4, 1894, thirty ıys after the last inoculation. All the blood obtainable was collected ıd the animal allowed to die while anæsthetized. It was very thin this time. In the lungs there were in all five foci of disease in which ıe lung tissue was converted into a necrotic mass containing large umbers of pus cells and many polar-stained bacteria. In the bronchi ıd trachea a considerable quantity of muco-purulent material contain-g not the polar-stained bacteria but small cocci deeply stained, in asses and mainly within pus cells. The lung lesions where they ached the pleura had produced an exudate attaching the lungs to ıe chest wall by means of still soft, easily broken adhesions.

The cause of these lung lesions was not definitely determinable. At st thought the subcutaneous inoculation thirty days ago appeared sponsible, but the location of the disease did not harmonize with this ıpposition. Usually the pleura is involved first and very extensively, ıd the lungs only secondarily by contiguity. Furthermore, the bac-ria present appeared slightly larger than those injected and were ery much attenuated, so that it required a comparatively large intra-nous dose to destroy a rabbit. Parallel bouillon cultures of this ıcillus differed quite markedly in appearance from those of the swine-ague bacillus originally injected.

The more probable supposition appeared to be that this rabbit was ıfected through the air passages with the bacillus of rabbit septi-emia* or influenza recently investigated by one of us in this laboratory, hich bacillus resembled the one from rabbit 446 closely, both in cul-ıres and in pathogenic activity.

Rabbit No. 441 was bled to death under ether January 8. This ıimal was in good condition and no internal lesions were found.

* Moore and Kilborne: An outbreak of rabbit septicæmia, with observations on ıe nature of the disease and its specific organism. American Veterinary Review, 393, Vol. XVII, p. 285.

Cultures from spleen and liver remained sterile. The serum was used as indicated in the subjoined table:

XVI.—*Table showing results of protective action of blood serum.*

Blood from	No. 446.	No. 441.							Inoculated with 0.06 cc. virulent bouillon culture.	Result.
When drawn	Jan. 4.	January 8.								
Date of injection of serum	Jan. 5.	Jan. 9.	Jan. 10.	Jan. 11.	Jan. 12.	Jan. 13.	Jan. 15.	Total.		
Rabbit—	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*	*cc.*		
No. 120	....	0.9	1	1	.....	0.5	0.5	3.9	Jan. 19....	Recovered.
No. 121	0.5	0.9	1	1	1	0.5	0.5	5.4	Jan. 19....	Dies Feb. 5.
No. 130	....	.....	.....	1	1.5	.....	0.4	2.9	Jan. 19....	Dies Feb. 12.
No. 129 (control)	....	.....	.....	.....	.....	.....	.....	.....	Jan. 19....	Dead in 20 hours.
Guinea-pig—										
No. 39	....	.....	.....	.....	1.3	1.0	0.75	3.05	Jan. 19....	Recovered.
No. 40	....	.....	.....	.....	1.3	1.0	0.75	3.05	Jan. 19....	Dead Jan. 30.
No. 41 (control)	....	.....	.....	.....	.....	.....	.....	.....	Jan. 19....	Dead Feb. 1.

The subsequent history of the three treated rabbits and the guinea-pigs is briefly told.

No. 121. January 22, three days after the test inoculation, the temperature was 103.3. A local swelling was noticed, about one-half inch in diameter and one-eighth inch thick.

January 24.—Temperature, 102.5. Local swelling larger, 1 inch across at base, one-half inch thick.

January 29.—Lesion as before. Up to to-day this rabbit has been eating, moving about, and playful.

February 5.—Rabbit dies very unexpectedly to-day. It was still playful this morning. The autopsy showed that the abscess at the place of inoculation had gradually destroyed the abdominal wall over an area one-fourth of an inch in diameter. The contents of the abscess, protected only by the peritoneum, projected into the abdominal cavity as a conical mass. The swine-plague bacteria had penetrated this delicate barrier and produced a fatal peritonitis. The viscid exudate contains immense numbers of swine-plague bacteria and a small number of leucocytes. Phagocytosis absent. The bacteria from this partly immune rabbit had not been attenuated. An inoculated rabbit died within 20 hours.

No. 120. On January 22, swelling 1 inch at base, one-half inch thick. Temperature, 102.2.

January 24.—Swelling much larger. Temperature, 102.9.

January 24. Swelling as large as a hen's egg. Up to date this rabbit has been more quiet than No. 121.

March 1. Rabbit now fully recovered. Weight has fallen from 2.5 to 2 pounds. On March 28, a slight gain in weight.

May 15. Has steadily increased in weight.

No. 130. On January 22, temperature 103.4. Swelling like that of No. 120.

January 24. Swelling larger. Temperature, 104.2.

January 29. Swelling as before. Skin breaking. This animal appears quiet but not sick.

February 12. Rabbit dies quite suddenly to-day, though apparently well for a week. Local lesion almost healed. No lesions referable to swine plague excepting perhaps a slightly roughened, opaque condition of the serous covering of caecum.

The experiment with the guinea-pigs did not give any clear results, as is shown in the table. No. 40 died January 30 with exudative pleuritis and markedly hyperaemic lungs. The control died two days later

ith same lesions. In both the exudate contained immense numbers f swine-plague bacteria. The third guinea pig (No. 39) recovered, but id not appear to thrive. It was chloroformed two months after the test ioculation, but no lesions were discovered. This equivocal outcome ius opens the question whether perhaps the immune rabbit's serum is ss efficacious when used upon some other species, such as guinea-pigs, ian when used on the same species; for the results obtained with rabt's serum on rabbits are strikingly positive.

)ES THE BLOOD SERUM OF IMMUNE RABBITS POSSESS ANY BACTERICIDE OR ANTITOXIC POWER?

The following experiment was tried with the blood serum of No. 441: To a given quantity, 0.6 cc., was added a small quantity of a bouillon ilture twenty-four hours old, equivalent in amount to one-tenth of the ood serum. This mixture was injected subcutaneously. The experient is tabulated below:

VII.—*Table showing results of injection of mixture of blood serum and bouillon culture.*

Rabbit—	Serum mixture contains—		Age of mixture when injected subcutaneously.	Result.
	Bouillon culture swine plague.	Serum.		
	cc.	cc.		
. 474 (5½ pounds)	.066	0.6	10 minutes	Dies in 24 hours.
. 119 (3 pounds)	.066	0.6	5 hours	Dies in 60 hours.
. 118 (3 pounds, control)	.066	0.6 sterile bouillon.		Dies within 20 hours.

In the rabbit receiving the serum mixture five hours old the disease is markedly retarded. On the following day, when the other rabbits ere dead, it was quite active and ate its food as usual. On the cond day the temperature had risen to 107.6° F. On the morning of e third day it was found dead. The bacteria had not been modid in this rabbit, for a minute, subcutaneous dose from a culture was al to a rabbit in 20 hours.

CONCLUSIONS.

The preceding observations and experiments have led to a few wellfined results, which we wish to summarize briefly. The hidden, undering, vital processes, according to which these results may be intereted, are either matters of controversy or else wholly intangible as yet. e content ourselves, therefore, in pointing out the more gross, inconovertible facts elicited, leaving the discussion of subtler problems and e citation of the mainly controversial literature for the present touched.

Immunity defined as a resistance to the invasion and multiplication pathogenic bacteria within the body is, when compared with susptibility, a condition of degree rather than of kind. There are varis degrees of immunity producible by one or the other of the methods

employed in these experiments, and in speaking of immunity experimentally produced it is necessary to state precisely the conditions under which such immunity is manifested. Thus a rabbit may be treated so as to resist successfully a fatal injection of swine-plague bacteria into the subcutaneous tissue. The same injection into the abdominal cavity or into the circulatory system may result in speedy death. Continued preventive treatment may indeed finally result in resistance to even these fatal doses. Our experiments have not been pushed to these extremes, and we are therefore unable to state whether, for instance, rabbits may be brought to this high level of immunity without a permanent injury to the organs and tissues, which injury manifests itself in the lower stages of the immunizing process by more or less prolonged emaciation. In the work before us the highest degree of immunity sought for in rabbits and guinea-pigs towards the bacteria of swine plague and hog cholera was a permanent resistance to those minimum doses of culture material which result fatally when injected under the skin of untreated animals.

The various processes we have employed in the production of immunity may be classed as follows:

(*a*) The use of attenuated cultures of living bacteria.

(*b*) The use of sterilized bouillon cultures.

(*c*) The use of sterilized bouillon suspensions of bacteria from agar cultures.

(*d*) The use of sterilized blood from animals in the last stages of the fatal inoculation disease.

(*e*) The use of blood serum from susceptible animals in which a certain degree of immunity had been produced by one or the other of the foregoing methods.

These five processes may be ranged under three main heads:

A (including *a*). The use of living bacteria.

B (including *b*, *c*, *d*). The use of the chemical products of bacteria.

C (including *d*, *e*). The use of certain still undefined substances in the blood, variously called antitoxins, alexins, etc.*

It may be that all of the methods given will be ranged, after more exhaustive investigations, under bacterial products, a view even now maintained by Büchner.† The relative efficiency of these processes is not precisely the same for both diseases experimented with, and for this reason, as well as for the sake of greater clearness, the result obtained with each species is best summarized by itself and comparisons made subsequently.

HOG CHOLERA.

If we compare the protective action on rabbits we shall find that of all the methods, the use of living, attenuated cultures was the only one which led to success. Even with this method the failures were many because the vaccinal doses were often too great or the culture of too high a degree of virulence. Rabbits are so susceptible to hog-cholera

* *d* is included under *B* and *C*, because it is proper to assume that in the blood of sick animals we have antitoxins as well as bacterial products present.

† Münchener med. Wochenschrift, 1893, Nos. 24, 25.

icteria that their immunization requires, as has been shown in the xt, not less than two preventive inoculations at an interval of one or ore months. It is not to be denied that immunity may be produced ith the use of sterilized agar suspensions, sterilized blood of diseased bbits or blood serum from immune rabbits, but these methods as pplied by us made no impression on rabbits whatever. When applied the same way in swine plague they produced a high degree of resist- ice.

The less susceptible guinea-pig reacted somewhat differently. Immu- ty was brought about with sterilized bouillon cultures but with vary- g results. Living attenuated cultures were not tried. Sterilized ;ar suspensions produced a slight retardation of the disease while erilized blood from diseased guinea-pigs failed to produce any impres- on. A slight retardation of the disease was also produced by the ood serum of immunized guinea-pigs but no retardation was noticed ien the blood serum from immunized rabbits was used.

SWINE PLAGUE.

A greater or less degree of immunity was produced in rabbits by erilized bouillon cultures, sterilized agar suspensions, sterilized blood om infected rabbits, and blood serum from immunized rabbits. Experi- ents on guinea-pigs were restricted to two methods. The sterilized ood of diseased rabbits was capable of producing immunity while the ood serum of immune rabbits produced rather equivocal results, as ible XVI shows.

In the following table those experiments are marked with the sign + which more or less immunity was produced, and those with the sign in which no appreciable resistance was noticed. Even those in iich only a distinct retardation of the fatal issue was produced are nsidered positive, for it is fair to assume that such retardation would ve become immunity if the treatment had been pushed a little fur- er:

Immunizing processes employed.	Rabbits.		Guinea-pigs.	
	Hog cholera.	Swine plague.	Hog cholera.	Swine plague.
peated injection of living ttenuated cultures.	+	....	....	
rilized bouillon cultures....	—	+ (16 cc. in 5 injections, ear vein.)	+ (10 cc. in 4 injections, 8 cc. in 8 injections.)	
rilized suspensions of agar ultures.	—	+ (7–8 cc. in 4 injections, abdomen.)*	Very slight effect.	
rilized blood of rabbits in ast stage of disease.	—	+ (6 cc. in 4 injections, subcutis.)	—	+ (5 cc. in 3 injections, subcutis.)
rilized blood of guinea-pigs n last stages of disease.	....	....	—	
od serum from immunized abbits.	—	+ (4 cc. in 5 injections, subcutis.)	Doubtful........	Doubtful.
od serum from immunized uinea-pigs.	....	....	+ (5 cc. in 5 injections, produced retardation).	

* Immunity produced in some cases with smaller doses. See Table XIV.

The experiments on swine with suspensions of agar cultures of hog-cholera bacilli demonstrate that immunity toward a fatal intravenous dose may be produced. Unfortunately no opportunity was offered to test the behavior of pigs protected in this way when exposed to the natural disease on the farm. The cost of preparing the sterilized suspensions would be a decided objection to their employment on a large scale.

We are well aware of the fact that only a beginning has been made by us in the study of experimental immunity with reference to these two important animal disease germs. A continued investigation of the collateral problems which have presented themselves in the course of the work is highly desirable, especially in the direction of seeking an answer to the question, why some species of animals are very susceptible, others only partially so, to the same pathogenic bacteria.

The definite progress made in this work is illustrated by the following important determinations:

1. It is possible to produce immunity toward hog-cholera and swine-plague bacteria in the very susceptible rabbit and the less susceptible guinea-pig. In the rabbit the only promising method of immunization toward hog cholera is the use of gradually augmented doses of attenuated cultures.

2. Immunization toward swine-plague bacteria is produced artificially with much greater ease than toward hog-cholera bacteria.

3. The blood serum of animals protected against hog cholera and swine plague is almost as efficacious in producing immunity soon after treatment as the bacterial products obtained from cultures.

4. Different degrees of immunity in both hog cholera and swine plague lead to different forms of the inoculation disease. The greater the immunity short of complete protection the more prolonged and chronic the disease, induced subsequently by inoculation.

5. Pathogenic bacteria may remain in the organs of inoculated animals some time after apparently full recovery. Their presence may or may not be associated with lesions recognizable by the naked eye.

6. The toxicity of sterilized cultures appears to be directly proportional to the number of bacteria in the injected fluid.

7. The results of Selander and Metchnikoff in the immunization of small animals were obtained with swine-plague and not with hog-cholera bacilli.

ON THE VARIABILITY OF INFECTIOUS DISEASES AS ILLUSTRATED BY HOG CHOLERA AND SWINE PLAGUE.

By THEOBALD SMITH and VERANUS A. MOORE.

The ideas incorporated in this article date back a number of years and owe their origin to the work on swine diseases carried on since 1885.

The first intimation of any variation in the virulence of bacteria from swine diseases was obtained by the isolation of swine-plague bacteria from different outbreaks.* Some of these varieties produced in rabbits after subcutaneous inoculation an exudative peritonitis fatal within a week. Others produced a septicæmia fatal within twenty-four hours.

In 1889 one of us pointed out the difference in the lesions produced in rabbits by the inoculation of two distinct varieties of hog cholera.†

Out of these observations grew the question whether these bacteria, morphologically and biologically identical, must be considered as different because of the different degrees of pathogenic power manifested by them. A long series of inoculations into rabbits made in 1889 with two hog-cholera bacilli of different virulence showed that the diseases induced by them could be made the same either by reducing the virulence of one of the varieties or increasing the resistance of the inoculated animal. The same was demonstrated by a preliminary experiment with virulent swine-plague bacteria in 1889.‡

The continuation of the investigations on preventive inoculation has enabled us to collect a considerable amount of information illustrative of variations in the gross manifestation of disease which may be brought about experimentally. This information we deem of great importance toward the proper understanding of infectious diseases as a whole, and hence present it here in as compact a form as possible.

* See Report on Swine Plague (1891) for a description of these bacteria.

† Bacillus α and Bacillus ζ, pages 9 and 13. *See also* the New York Medical Journal 1890—ii, p. 485.

‡ Report on Swine Plague, p. 148.

SWINE PLAGUE.

Among the forms of disease which we have observed after the subcutaneous inoculation of rabbits with swine-plague bacteria from different sources are the following:

1. Septicæmia.
2. Peritonitis.
3. Pleuritis (usually with pericarditis).
4. Pleuritis (usually with pericarditis) and peritonitis.
5. Local lesion only.

In the septicæmia death ensues within eighteen to twenty-four hours. The local lesion produced at the seat of inoculation is slight. Bacteria are abundant in the parenchyma (blood vessels) of the various organs. In the form characterized by peritonitis death ensues in three to seven days. The local lesion, which in all these forms of disease increases in extent with the prolongation of the life of the animal, is here characterized by more or less suppurative infiltration of the skin and the subcutis. The peritonitis in its earlier stages is characterized by punctiform hemorrhages on the cæcum and an exudate varying in character, being fibrinous or cellular. It always contains immense numbers of bacteria. When pleuritis is also present the exudate usually involves the pericardium as well. It varies in amount according to the duration of the disease and is essentially the same as the peritoneal exudate.

The form characterized by pleuritis and pericarditis without peritonitis is interesting in so far as the seat of inoculation does not explain the localization, for, in every case, the inoculation was made in the region of the abdomen. The lungs may become hepatized secondarily through invasion from the pleura if the animal lives long enough.

Lastly, the form of disease in which the only localization is a very extensive suppurative infiltration associated with hemorrhage and œdema of the subcutaneous tissue is not common.

It should be stated that the cultures from the same outbreak continued to produce the same form of disease in rabbits until modified by age. The maintenance of a certain uniform virulence for years is well exemplified by a variety isolated in the summer of 1890.* This variety was fatal to rabbits within twenty hours when first isolated, and this degree of virulence has maintained itself up to the present, a period of nearly four years.

Inasmuch as numerous illustrations of these forms of swine-plague in rabbits may be found in the report on swine-plague and in the reports of the Bureau of Animal Industry since 1886, we refrain here from citing any cases.

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* Bulletin on Swine Plague, p. 57.

MODIFICATIONS OF THE SEPTICÆMIA TYPE BY INCREASING THE RESISTANCE OF RABBITS.

By the various processes recorded in the preceding article which increase the resistance of rabbits we have been able to produce nearly all the pathological variations which follow the inoculation of natural races of swine-plague bacteria as isolated from outbreaks. This modification of the septicæmia type is not fortuitous, for among the large number of rabbits inoculated during the past three and one-half years with the culture employed none have survived twenty to twenty-four hours. Whenever the course of the inoculation disease in rabbits departed from this rapidly fatal type it was due to some preliminary treatment of the rabbit.

The degree of resistance determined quite regularly though not invariably the form of the disease. This degree was measured by the relative quantity of the protective material (sterilized cultures, sterilized blood, and blood serum) injected. The grades of disease induced range themselves in the following order:

1. No resistance—acute septicæmia.
2. Slight resistance—peritonitis.
3. Increased resistance—pleuritis and pericarditis with or without secondary pneumonia.
4. Higher degree of resistance—pleuritis and peritonitis.
5. Still greater resistance—irregular lesions in the form of abscesses, subcutaneous and subperitoneal.
6. Nearly complete immunity. Very slight reaction at the point of inoculation.

Most of the cases cited below as illustrating these modified forms of the septicæmia type belong to the series of immunizing experiments of the preceding article. To this the reader is referred for additional illustrations.

First degree of resistance—peritonitis.—Rabbit No. 12 received 7 cc. of bouillon culture of swine-plague bacteria sterilized by heat. Subsequently with a control rabbit it was inoculated with a minute dose of swine-plague bacteria under the skin. The control died within eighteen hours, the treated rabbit in three days. The macroscopic changes were limited to the point of inoculation and the peritoneum. At the former there was a purulent infiltration of the subcutis, 1.5 cm. in diameter, with dilatation of surrounding blood vessels. The peritonitis was characterized by an exudate of a slightly viscid character covering liver, spleen, and cæcum, and made up of fibrin, leucocytes, and immense numbers of bacteria.

Second degree of resistance—pleuritis and pericarditis.—Rabbit No. 38* was treated before inoculation with 4.5 cc. of a sterilized suspension of agar cultures of swine-plague bacteria in 3 doses. Together with a control rabbit, it received under the skin the equivalent of 0.001 cc. of a fresh bouillon culture of swine-plague bacteria. The

* See Bulletin on Swine Plague, p. 148, for the entire experiment tabulated.

control died in twenty hours. The treated rabbit died six days after inoculation. At the point of inoculation there was a purulent infiltration of the subcutis 3 cm. in diameter. The abdomen and abdominal viscera were free from macroscopic changes. In the thorax, the pleural cavity was lined with a grayish, friable exudate consisting of round cells and bacteria. Lungs hyperæmic and only partly collapsed. Pericardium also covered with a slight exudate.

Third degree of resistance—pleuritis (pericarditis) and peritonitis.—Rabbit No. 15 received in the ear vein 12 cc. of a sterilized bouillon culture of swine-plague bacteria. It was inoculated subcutaneously with virulent swine-plague bacteria May 26, and died June 3, eight days later. The control rabbit died within eighteen hours. The following changes were observed:

A purulent infiltration into the subcutaneous tissue at the point of inoculation extending over an area 6 cm. in diameter. The superficial layer of the subjacent muscle discolored. Surrounding the area of infiltration the blood vessels were injected. The cæcum and liver were covered with a very thin grayish exudate, which also appeared on and between the coils of the intestine. Spleen not enlarged.

The right lung and chest wall covered with a thin grayish exudate. In the cephalic lobe, two small areas of consolidation; principal lobe hyperæmic. The left pleural cavity lined with a quite thick membranous exudate, which covered the entire surface of the lung. On the dorsal surface of the principal lobe a mass of lung tissue 2 cm. in diameter, firm and of a yellowish-gray color. The remaining portion of the principal lobe hyperæmic; cephalic lobe in state of collapse.

Pericardium covered with a thin cellular exudate.

Higher degrees of resistance.—None of the treated animals which have come under our observation, have succumbed to a mere extension of the lesion produced at the point of inoculation as is occasionally observed after inoculation with certain varieties of swine-plague bacteria found in nature. There have been noticed, however, certain peculiar localizations resembling those produced in the subcutis after inoculation, and in a few cases the local lesion persisted a considerable length of time. It was quite severe in all fatal cases in which the disease was prolonged several weeks after inoculation, although the real cause of death was due in all such cases to localizations on one or more of the serous membranes. The peculiar forms of disease may be grouped as follows:

(*a*) *Persistence of local lesion.*—Rabbit No. 50 received in the abdominal cavity 3.5 cc. of the sterilized suspension of agar cultures in 3 doses. It was subsequently inoculated beneath the skin with 0.001 cc. of a bouillon culture of swine-plague bacteria which produced a large local swelling. On February 25, 1892, nearly eight months after its inoculation, it was chloroformed. The only lesion found was in the subcutaneous tissue. At the point of inoculation the skin was sloughed over an area 3 cm. in diameter. This denuded surface was covered with a thick scab. The subcutis beneath the scab and surrounding the ulcer was infiltrated with pus. A stained cover-glass preparation showed swine-plague bacteria. No other lesions were found.

(*b*) *Sub-peritoneal abscess.*—Rabbit No. 16 was injected intravenously with 16 cc. of sterilized bouillon cultures of swine-plague bacteria. After some days it was inoculated beneath the skin with 0.001 cc. of a fresh bouillon culture of virulent swine-

plague bacteria. The control rabbit died within twenty hours. Rabbit No. 16 showed no ill effect from the inoculation for several months when it was noticed that it was becoming emaciated. It died June 11, 1892, one year and six days after its inoculation with an enormous subperitoneal tumor, which is described on page 67.

(c) *Multiple abscesses under the skin.*—Rabbit No. 439 received into the ear vein in 3 injections 4 cc. of sterilized blood from a swine-plague rabbit. Later it was inoculated subcutaneously with 0.001 cc. of a bouillon culture of virulent swine-plague bacteria. The control rabbit died within twenty hours. Two months after the inoculation it was noticed that this rabbit with others was suffering from a large number of subcutaneous abscesses, described on page 72.

HOG CHOLERA.

The lesions produced in rabbits after subcutaneous injection of the most virulent variety of the hog-cholera bacillus (the one most frequently encountered) have been given on page 10. The lesions produced by the less virulent varieties may either resemble these on intravenous inoculation or else they may be quite different both after subcutaneous and intravenous inoculation. That variety of the hog-cholera bacillus described as ζ on page 13 presents some striking differences, to which reference has already been made by various illustrative cases. In the illustrations given below the macroscopic changes in those animals which succumbed to a more prolonged chronic illness were concentrated in the follicular apparatus of the intestines and the lungs.

Modified disease produced in a rabbit with hog-cholera bacilli attenuated by heat.—The culture used had been exposed for thirty-eight days to 43.5° C. to 44° C., according to the procedure described on page 42. The rabbit received subcutaneously 0.12 cc. of a fresh bouillon culture twenty-four hours old. It died in twenty days. The temperature during the disease remained rather low, fluctuating between 103° and 104° F. On the fourteenth day it began to sneeze and cough and a few days later a muco-purulent discharge from the nose appeared. On the twentieth day it was unable to get up and was chloroformed. The lesions were in brief as follows:

At the point of inoculation a small abscess; spleen moderately enlarged; liver free from necroses; the bunch of lymph glands at root of mesentery as large as a horse chestnut and mottled with whitish foci; the Peyer's patches at ileo-cæcal valve are thickened; the follicles very large, whitish; the overlying mucosa ulcerated; the lungs were also involved; the entire right ventral and a portion of the right cephalic lobe involved in broncho-pneumonia; the left principal lobe is solid, dark red on section; the air passages contain a thick muco-pus.

Portions of an ulcerated Peyer's patch, of the enlarged mesenteric glands, and of the lungs hardened in alcohol were submitted to microscopic examination. The follicles and the follicular tissue of the Peyer's patch owe their swollen condition to leucocytic infiltration in the depths of which a few clumps of hog-cholera bacilli are brought out by methylene blue. In the gland the whitish foci were found to be collection of leucocytes, largely broken down, in which are embedded clumps of bacilli. The pneumonia was characterized by dense cell infiltration of alveoli and small air tubes with desquamation of cells in the alveoli around the broncho-pneumonic foci.

A rabbit was inoculated subcutaneously with 0.5 cc. of a culture of the hog-cholera bacillus exposed to 43.5° to 44° C. for one hundred and ninety-five days. Rabbits inoculated at the same time with smaller doses survived, while this one died, very much emaciated, in thirty-seven days. The local lesion was encysted, and the only other changes consisted of twelve infiltrated follicles in the appendix and about six similarly affected follicles in the Peyer's patches in ileum and cæcum, near the valve. The mucosa overlying the cæcal patch shows two excavated ulcers with irregular edges.

A rabbit was inoculated by injecting 0.12 cc. of peptone bouillon culture into an ear vein. The bacilli used were from the culture described as β (page 10), and at the time of injection nearly seven years old. The attenuation was thus due to prolonged cultivation. The rabbit succumbed in four days. Besides the usual parenchymatous changes, there had developed a pneumonia, involving the right ventral and azygos lobe in hepatization. The trachea and bronchi contained much catarrhal exudate.

The lesions produced by the inoculation of virulent material into rabbits, in which a partial immunity has been induced are similar to those produced by attenuated cultures in rabbits having no artificial protection. This is well illustrated by the following case:

Rabbit No. 13. June 12, 1889, receives subcutaneously 0.05 cc. bouillon culture of virulent hog-cholera bacilli exposed to 43.5° to 44° C. for ninety-eight days. The temperature rose to 106.8° F. four days after inoculation and fell to normal in two weeks.

July 16. Subcutaneous inoculation of 0.05 cc. unattenuated culture.

October 1. Subcutaneous inoculation with a particle of spleen pulp from a rabbit.

December 14. Found dead to-day. The lesions are very interesting as compared with acute hog cholera.

Intestines.—Much mucus present in small and large intestines. Peyer's patch in cæcum near valve infiltrated and on the mucous surface converted into a yellowish brown slough. In the cæcum itself along the mucous folds are groups of slightly depressed firm sloughs of the mucosa. Similar ulcers in upper portion of colon. In the appendix all the follicles are whitish and more or less swollen, some 4 to 5 mm. in diameter and projecting into lumen of tube. Mucosa not necrosed.

Spleen large, dark, and soft. Liver dotted with a considerable number of grayish spots. The presence of coccidia makes their nature doubtful. On the surface of both kidneys there are 50 to 75 firm nodules, variable in size, the largest being 4 mm. in diameter and projecting hemispherically above the surface. They dip down into cortex as elongated masses of a caseous appearance and firm consistency.

The lungs remain fully expanded on opening thorax. With the exception of a narrow border on cephalic lobes they are completely hepatized. The surface, of a bright red color, is beset with pale yellowish irregular spots 1 to 4 mm. in diameter. These spots are not well defined, but surrounded by a hazy nebulous border. They correspond to nodules in the lung tissue which are of a cheesy consistency and crumble on pressure.

In sections of hardened tissue the lung is found containing necrotic foci surrounded by a zone of alveoli filled with round cells and more or less new connective tissue.

The hog-cholera bacillus was still present in the spleen. A colony from an agar culture produced the characteristic acute fatal disease in rabbits. Any attenuation of the bacillus not noticeable.

The localization of hog-cholera bacilli, injected into the circulation, in the brain substance, and the production of a focus of necrosis and suppuration, is illustrated by the rabbit referred to on page 43 of this bulletin. In this case macroscopic changes in other organs were not detected.

A FORM OF PSEUDO-TUBERCULOSIS PRODUCED IN RABBITS AND GUINEA-PIGS AS A RESULT OF INCREASED RESISTANCE OF THE ANIMALS OR ATTENUATION OF THE VIRUS.

A.—GUINEA-PIGS.

This form of inoculation disease was first noticed in guinea-pigs in 1890. The resistance of the guinea-pigs had been increased by various methods. Some of them survived the inoculation of the usually fatal dose of hog-cholera bacilli. Others succumbed to a prolonged disease, during which the pseudo-tubercles to be described were formed.

These tubercles situated, as a rule, in the subserous tissue of the abdomen and under the pulmonary pleura, are small, slightly convex bodies of a whitish or neutral gray color. In form they are roundish or slightly elongated. In size they vary from barely recognizable dots to bodies 2 mm. in diameter. They are firm in consistency and give the sensation of hard, granular bodies. In appearance they are strikingly like the true tubercles when the latter are situated on the serous membranes. In fact when they were first noticed it was thought that the guinea-pig had been inoculated accidentally with tuberculous material.

In sections, cut by the paraffin method, these bodies were found to consist of aggregations of round cells of which the central portion was largely disintegrated. No limiting membrane, stroma, or giant cells have been found. When crushed with forceps and examined under the microscope in a fresh condition cells more or less degenerated are the only tissue elements observable. In properly stained cover-glass preparations made from the crushed bodies hog-cholera bacteria were found in considerable numbers. Similar preparations from the blood, spleen, and liver of the same animal failed to show them.

These pseudo-tubercles were almost always present in guinea-pigs which lived four or more days longer than the control animals. In a similar series of experiments made by Dr. E. A. de Schweinitz in 1890 with substances isolated from pure cultures of hog-cholera bacteria the pseudo-tubercles were found when an increased resistance equivalent to only one or two days had been induced.*

In the experiments to test the immunizing efficacy of sterilized cultures of hog-cholera bacteria (p. 46) thirteen guinea-pigs died in four or more days after the control animals. In nine of these the pseudo-tubercles were found.† It is of interest to note that in a few guinea-pigs

*Medical News, October 4, 1890.

† For the history of the four other guinea-pigs (Nos. 477, 19, 478, and 438), see p. 47.

that were killed for examination several months after inoculation the tubercle-like bodies were not found.

The distribution* of the pseudo-tubercles in the body of the guinea-pigs varied considerably in the different animals. They were either quite generally distributed beneath the serous membranes or confined within circumscribed areas, where they came into actual contact one with another or were separated by a distance of from 0.5 to 3 mm. The localities in which they have been found, beginning with the most common, are as follows:

1. Beneath the peritoneum, more especially along one side of the spinal column or else aggregated in limited areas from 3 to 5 cm. in diameter. When separated by only a short distance the nodules were frequently connected by delicate grayish lines.
2. In the heart muscle.
3. Beneath the pleura of diaphragm and lungs.
4. In the mesentery.
5. In or beneath the fascia covering the abdominal wall.

The Malpighian corpuscles in the spleen were frequently enlarged, so that they resembled the pseudo-tubercles very closely.

In addition to the pseudo tubercles there were a few other lesions not usually found in the control animals which indicate a further change in the course of the disease. These variations usually accompany the development of pseudo-tubercles, although they may appear in a less marked form in animals that die presumably before the nodules beneath the serosa are formed. The most important of these variations are as follows:

(*a*) The purulent infiltration into the subcutaneous tissue at the point of inoculation was less severe than in the control animals.

(*b*) The areas of necrosis in the liver were less marked, but there was observed a diffuse fatty degeneration of the parenchyma.

(*c*) The enlargement of the spleen was less marked and the color more normal.

(*d*) The inguinal and knee-fold lymph glands were more enlarged and the follicles in Peyer's patches more frequently infiltrated.

(*e*) A membranous exudate was usually noticed over the spleen and liver, frequently accompanied with effusion of serum into the peritoneal and pleural cavities.

B.—Rabbits.

An eruption of tubercle-like bodies was produced on the peritoneum in rabbits by the intraabdominal injection of hog-cholera bacilli attenuated in mixed cultures. The lesions are best described by a case:

February 10, 1891. Two rather small rabbits inoculated with the attenuated hog-cholera culture, one receiving 0.2 cc. subcutaneously, the other 0.15 cc. into abdomen. The former showed no indications of disease at any time; the latter died in nine days.

The autopsy revealed in the abdomen on ventral walls beneath serosa a large number of whitish, slightly elevated, roundish tubercle-like

* For cases illustrating the occurrences of these nodules, the reader is referred to the post-mortem notes of guinea-pigs Nos. 3,10, 13, 17, and 18 on page 47.

bodies 1 to 1.5 mm. in diameter. They are also present in large confluent patches on serosa of cæcum. The Peyer's patches of intestines are infiltrated, the mucosa eroded over some of them. The mesenteric and retro-peritoneal lymph glands contain whitish suppurative foci. In the liver are disseminated numerous minute foci of necrosis. Heart and lungs normal. Some of the tubercles are easily teased out of their surroundings. When broken up, rubbed on cover glasses, and stained numerous mononuclear cells and a considerable number of hog-cholera bacteria appear. In sections of hardened tissue these tubercles appear as a collection of cells under serosa, the center of which shows extensive fragmentation of nuclei. Giant cells are not seen. In the center of many of these foci clumps of hog-cholera bacilli are located. Cultures from this case were plated, and on March 4 a large black rabbit receives into abdomen 0.1 cc. of a bouillon culture twenty-four hours old made from a colony. It was found dead March 13 and showed the following peculiar lesions:

Thorax.—Heart somewhat dilated. Fatty degeneration of walls. Under serosa of lungs very minute translucent tubercles. On tip of right ventral lobe, which is hyperæmic, several large, opaque, whitish tubercles.

Abdomen.—Diaphragm and mesenteries sprinkled with very many minute opacities. On serosa of stomach barely visible tumefactions or tubercles. On spleen a large number of minute grayish tubercles. On liver many barely visible whitish points. Follicles of Peyer's patches infiltrated, mucosa necrosed. The same is true of follicles in appendix of cæcum. Scattering patches of necrosis in cæcum. Suppurative foci in mesenteric glands. Kidneys large with marked parenchymatous degeneration of cortex and cyanotic appearance of medulla. From this case also the injected bacilli were isolated from the spleen.

The foregoing experimental observations lead to certain important deductions, which throw light not only on the subject of preventive inoculation but also on the interrelation of certain groups of infectious diseases.

We have seen that there are certain varieties of the same species of pathogenic bacteria in nature which produce different types of the same disease when inoculated into susceptible animals. We have also seen that the disease produced by the most virulent variety may be so modified by increasing the resistance of the animal as to resemble the various types produced by the more attenuated natural varieties. Lastly, we have demonstrated that some of the types of the inoculation disease as observed in partly immunized animals may be reproduced in fully susceptible animals by the inoculation of an artificially attenuated culture. This relation between the degree of virulence of certain bacteria on the one hand and the relative resistance of the animal body on the other may be expressed by the simple formula—

$$d = \frac{v}{r}$$

in which v = virulence, r = the degree of resistance or immunity of the animal, and d = the type of disease. By changing either virulence

or resistance the type is changed. When we reduce the virulence we obtain about the same disease as when we leave the virulence unchanged and increase the resistance of the animal by some kind of preventive treatment, i. e., the value of *d* remains the same.

Somewhat similar statements have been recently made by Charrin * concerning the pyocyaneus infection in rabbits. He notes much variation in the lesions of any one set of organs, such as the kidneys. His observations, however, pertain more to histological changes, whereas our facts bear on the distribution of macroscopic lesions over the entire body. Charrin injects into an ear vein and thereby at once distributes the disease over the entire vascular system. In many of our experiments the inoculation was merely subcutaneous, and hence the bacteria must be diffused along different routes in order that the peculiar restriction of the disease processes may take place. Thus, in the limitation of the swine-plague bacteria to the pleura after subcutaneous inoculation over the lower part of the abdomen, or in the infiltration and suppuration of Peyer's patches after the subcutaneous injection of hog-cholera bacilli, the route of the bacteria is much more circuitous than in simple intravenous injection, where we may conceive of a complete suppression of the growth of the injected bacteria, excepting at the seat of the lesions. It is not our purpose to attempt an explanation of the phenomena brought out by the immunizing experiments. A complete explanation would presuppose a complete elucidation of the problem of immunity in all its bearings.

A further corollary of much importance may be deduced from these experiments. By increasing the resistance of the smaller experimental animals or by reducing the virulence of the inoculated bacteria we obtain a type of disease simulating that of larger, more resistant species of animals, such as swine. This is very well illustrated in the two diseases experimented upon.

1. By modifying the hog-cholera disease in rabbits so as to prolong it to twice or three times its usual period we obtain instead of the usual septicæmic type, as described on page 10, a true hog cholera as it manifests itself in swine. The lesions become localized in the digestive tract. The solitary and agminated follicles become infiltrated and converted into ulcers and the mucosa of the cæcum may become ulcerated in large patches, as in the cholera of swine. In some rabbits the disease may become localized in the lungs, as is now and then the case in swine.

2. By modifying swine plague in rabbits so as to prolong the disease from twenty hours to a week or more, a localization of the disease in the thoracic organs appears, which corresponds closely with the disease in swine. The bacteria appear to multiply first in the pleural cavity and then to invade the lung tissue secondarily, for the pulmonary lesions may be absent or else restricted to those dependent lobes on which the pleural exudate is most abundant.

These results make it intelligible how much the disease of hog cholera, for example, may vary in pigs in accordance with any variation in the virulence of hog-cholera bacilli and the relative immunity of

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* Comptes rendus de la Société de Biologie, 1893, pp. 730, 762.

swine, and how difficult it is to decide upon the causation of any particular set of changes in the animal without having recourse to the bacteria involved. We may take it as settled that, in general, swine are not very susceptible to both hog cholera and swine plague. This is proved by the difficulty encountered in producing either disease artificially with pure cultures. The localization of the disease, as compared with the disease in rabbits, also shows this to be true. In other words, when epizoötics of either disease appear among swine they are due largely to aggravating circumstances, and the removal of these is the key to the prevention of swine diseases.

Preventive inoculation, as it has been practiced on domestic animals, does not always insure absolute immunity. Since all immunity is relative and a matter of degree, the resistance of the animal vaccinated will depend upon conditions both internal and external. While vaccination may protect from an acute attack, it may lead to a slower, more chronic disease, not easily recognized, but equally if not more dangerous than the more acute disease, because the animal may become the source of infection for other animals. Such animals are also a loss to the owner, as they are not in a condition to thrive, and will succumb to the chronic affection sooner or later.

Interesting confirmation of these deductions from experimentation with the bacteria of hog cholera and swine plague comes from studies of a European swine disease, *rouget*, or swine erysipelas. This disease exists in nature in about five varieties, and some of these varieties are produced by the process of vaccination. Originally described as a rapidly fatal septicæmia in swine, it has been observed in recent years that it may also appear as an endocarditis. On the inner surface of the heart —usually the left ventricle—wart-like growths are found occupying the mitral valve and almost completely obstructing the flow of blood from auricle to ventricle. In these growths there is a considerable deposit having the character of a thrombus, and in this soft mass rouget bacilli vegetate in large numbers.

This rouget endocarditis has been observed both as a result of vaccination with Pasteur's vaccine and in the course of the natural disease. Hess and Guillebeau * have given some good illustrations of this type of the vaccination disease. Some of the pigs become ill after vaccination and never make a good recovery. In these after death or slaughter the infectious endocarditis is found.

The same form of heart affection was found by Bang † quite common in Denmark. The course of the affection as observed by veterinarians in that country was as follows:

When rouget appeared in a herd of swine it would usually cause more or less acute disease with a certain number of deaths. The

* Schweiz. Archiv f. Thierheilkunde, XXVIII, 1886.

† Ueber Rothlauf-Endocarditis bei Schweinen. Deutsche Zeitschrift f. Thiermedicin, XVIII (1891), p. 27.

remainder of the herd would make a good recovery. One or more months later some would die quite suddenly, the cause of death being infectious endocarditis as a result of the vegetation of rouget bacilli on the valves of the heart. Cases of heart disease were also observed which had not passed through any recognizable acute attack of rouget previously.

Recently C. O. Jensen* described in detail an infectious disease of swine in Denmark, known as urticaria (*Nesselfieber*), which is a modification of the same rouget disease of the continent. At about the same time Dr. Lorenz† described a disease as occurring in Germany which Jensen considers identical with urticaria. It occurs more especially in the warmer season of the year and very rarely ends fatally. At the onset of the disease the pigs become dull, crawl into their bedding, breathe more rapidly, and refuse all food. The temperature rises and may reach (42° C.) 107.6° F. Soon after the onset of these symptoms a peculiar eruption appears on the body, which consists of red, brown, blue, or blackish spots, rectangular in form and sharply outlined (hence the German name *Backsteinblattern*). The longer side of this rectangular reddened spot may be one-half to one inch long, the shorter side about one-third less.

The disease disappears after a few days, but the spots may persist one or two weeks, after which a blackish scab peels off. Lorenz cultivated from one of these red spots a bacillus which closely resembles the bacillus of rouget, both in its biological and pathogenic properties. Rabbits which survived inoculation with rouget resisted successfully inoculation with these bacilli. Jensen's description closely agrees with that of Lorenz. The latter calls attention to the red spots as being not always rectangular, but also roundish or diamond shaped. Jensen in the same article also describes a disease in swine associated with necrosis and sloughing away of large pieces of the skin, sometimes one or more square feet in area. The microscopic examination of such sloughs revealed the presence of large masses of bacilli identical with those of rouget.

Jensen gives the following affections of swine as due to the same bacillus:

1. *Rouget blanc.*
2. Rouget as it is usually known.
3. Diffuse necrotic inflammation of the skin.
4. Urticaria.
5. Endocarditis verrucosa bacillosa.

The careful comparison of cultures from all of these affections, excepting No. 3, of which cultures were not at hand, revealed such slight variations as are common to other species of bacteria.

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* Die Aetiologie des Nesselfiebers u. der diffusen Hautnekrose des Schweines. Deutsche Zeitschrift f. Thiermed, XVIII (1892), p. 278.

† Archiv. für wiss. u. prakt. Thierheilkunde, XVIII (1892), p. 39.

The form of inoculation disease characterized by the presence of pseudo-tuberculous lesions has certain counterparts in some inoculation diseases among lower animals which have been studied by various observers. In order to trace any possible relationship between the group of hog-cholera bacteria and those that have been described as the cause of experimental pseudo-tuberculosis in rabbits and guinea-pigs the literature of this subject has been examined.

Pseudo-tuberculosis in guinea-pigs was first produced by Malassez and Vingal* and reported in 1883 as "tuberculose zoogloeique." Cultures of the bacteria described as occurring in the tubercles were not made.

Soon after Eberth† described an eruption of submiliary tubercles on the serous membrane of the colon; on the omentum and in the spleen and liver of a rabbit. The tubercles consisted in the main of granulation cells. The bacteria present, according to the description given, resembled hog-cholera bacilli in form and staining. Cultures were not made, however.

In 1888 Charrin and Roger ‡ described a pseudo-tuberculous affection produced in rabbits and guinea-pigs by a motile bacillus from 1 to 2 μ long, which multiplies well in ordinary culture media. The bacillus was originally obtained from a guinea-pig which died spontaneously. A subcutaneous inoculation leads to slow emaciation, and death on the thirteenth day. Besides the local swelling, the nearest lymph glands become enlarged, and numerous tubercles are found in spleen and liver. In the lungs they are scarce.

Dor § found what appears to be the same disease independently of Charrin and Roger. The bacillus he isolated contains, in potato cultures, terminal spores. The disease could not be reproduced with cultures, although the pathological products readily produced it. This leaves the impression that the bacillus isolated was not the one causing the tubercles. Grancher and Ledoux,|| in 1888, obtained from the soil a bacillus which produced lesions similar to those described by former observers as pseudo-tuberculosis. This organism is described as a motile bacillus 1 to 2 μ long, which may, however, assume the form of a very short rod or an ovoid micrococcus. The optimum temperature of the culture is 20° C. This is perhaps the only point in which this bacillus differs appreciably from the colon or hog-cholera group. It should be stated, however, that important cultural characters, among them the action on milk, are omitted. In the tissues the organism grows in the form of long interlacing chains, of which great masses may appear in certain types of the inoculation disease as the so-called

*Arch. de physiol. normale et pathol., 1883.

†Arch. f. pathol. Anatomie, CIII (1886), p. 488.

‡ Comptes Rendus, 1888–i, p. 868.

§ *Loc. cit.*, p. 1027.

|| Recherches sur la tuberculose zoogléique. Archives de Méd. Expér., I (1889). p. 203

zoöglœa of Malassez and Vignal. In some types of the disease produced by inoculation the prompt appearance of tubercles may suppress the formation of the zoöglœa. The bacilli may then appear in the tubercles, either isolated or in small masses.

A. Pfeiffer* published in 1889 a short monograph on a form of pseudo-tuberculosis produced by a bacillus originally derived from a glandered horse. Portions of a lung nodule and of a diseased gland were placed under the skin of guinea-pigs with the result that pseudo-tuberculosis and not glanders destroyed the inoculated animals in eight to nine days.

The isolated bacillus differs according to Pfeiffer's detailed careful description only in a few particulars from the hog-cholera group. It is non-motile† and grows preferably in chains. The markings of the surface colony on gelatin plates are also somewhat different from those observed in the hog-cholera and the colon group. Nevertheless the characters as described place this bacillus easily within the hog-cholera group and separate it from the colon group by the absence of any coagulative or other changes in milk.

The lesions observed by Pfeiffer varied somewhat. In the earliest inoculations into guinea-pigs, there was marked infiltration of the inguinal glands with dissemination of nodules in the surrounding connective tissue, in omentum, spleen, and liver. In subsequent inoculations, with death in nine days, the mesenteric glands were greatly enlarged, miliary and submiliary nodules were present in large numbers in spleen and liver. In the spleen there was also a caseous tubercle as large as a pea. The inguinal glands as before.

In still later inoculations, the guinea-pigs died in twenty to twenty-five days. The lesions were still more extensive. To those already described there were added a serous fluid in abdomen, a cheesy deposit on pleura, with a sanguinolent fluid in the pleural cavity, and numerous necrotic foci in the lungs.

By feeding cultures to mice, rabbits, and guinea-pigs, the disease is produced with equal success. The pseudo-tuberculous infiltration is restricted to the lymphatic apparatus of the intestines and to the liver. Among the animals found susceptible are guinea-pigs, wild and tame rabbits, gray and white house mice.

Zagari‡ in 1890, described a form of pseudo-tuberculosis encountered as a spontaneous or natural infection in four guinea-pigs. The isolated bacillus appears in cultures as a non-motile form in long chains, easily broken up, and in shorter oval elements. Its cultural characters so far as given do not differ materially from those of the hog-cholera group. The bacilli appear in masses in the center of the tubercles which con-

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* Ueber die bacilläre Pseudo-tuberculose bei Nagethieren. Leipzig. 1889.

† See Bacillus η, page 16.

‡ Ueber die sogenannte Tuberculosis "zoogleica" order Pseudo-tuberculose. Fortschritte der Medicin. 1890, pp. 569, 629.

sist of lymphoid elements chiefly. The center of the tubercles may undergo necrosis and caseation. After subcutaneous inoculation of culture fluid a firm infiltration appears at the seat of inoculation which may reach the size of a walnut and subsequently ulcerate. Death ensues in twelve to sixteen days. The neighboring lymph glands are found enlarged. In spleen, liver, and lungs many yellowish, isolated tubercles from the size of a hemp seed to that of a pea are found.

From this brief summary of the bacteriological side of the pseudo-tuberculosis literature we see certain general resemblances between the bacilli found and those belonging to the hog-cholera group. The differences observed are by no means vital. We do not wish to argue for or against any close relationship, however, until more data are at hand. The production of tubercles with attenuated hog-cholera bacteria or with virulent bacteria in partly immune animals is of sufficient importance to warrant the above summary. Further study of spontaneous pseudo-tuberculosis might perhaps lead to a better understanding of the origin of the hog-cholera group of bacteria.

The foregoing investigations throw much light upon the possible variations of all infectious diseases, both human and animal. We need but recall here the great variety of lesions produced by the ordinary septic and pyogenic bacteria of man, the staphylococci and the streptococci. Furthermore, most specific infectious diseases show variations in type, variations in the localization of the most distinctive pathological alterations. Some obscure forms of disease still needing elucidation may perhaps be recognized in the future as modifications of such as are already understood. As illustrations may be cited the recent discussions as to whether certain obscure diseases of man are of leprous origin or not, or whether scarlatina is a simple form of streptococcus infection. The outcome of our work emphasizes the importance of renewed continuous etiological studies. In infectious animal diseases this is of the utmost importance, for the unrecognized existence of some form of an infectious disease favors its unchecked dissemination. The confusion which has prevailed on the subject of infectious swine diseases must be attributed largely to the many possible variations in the symptoms and lesions as determined by post-mortem examinations. Such variations are due on the one hand to the condition of the animal as regards individual resistance, age, breed, the state of the internal organs, the amount of fat, etc., on the other to the virulence of the specific bacteria. The only final test of the nature of the disease is the character of the bacteria responsible for it.

CAN THE BACILLUS OF HOG CHOLERA BE INCREASED IN VIRULENCE BY PASSING IT THROUGH A SERIES OF RABBITS?

By Veranus A. Moore.

In 1890 Selander* reported the results of certain experiments with the bacillus of *Svinpest* (Danish hog cholera), in which he showed that its virulence could be rapidly accelerated by passing it through a series of rabbits or pigeons. He furthermore affirmed that the germ was identical with the bacillus of American hog cholera. This most remarkable result, which was quite contrary to the conclusions which had been reached from the work in this laboratory, gave rise to the presumption that his culture had inadvertently become contaminated with the swine-plague or some other organism more virulent than the bacillus with which he was working, and consequently the question was temporarily dismissed.

In 1892 the results of Selander were confirmed by Metchnikoff† in an article on certain experiments concerning the immunizing properties of the products of hog-cholera bacteria. As no extended experiments had been made in this laboratory in precisely the line followed by Selander, it became necessary after Metchnikoff's publication to determine more positively whether or not the bacillus of hog cholera was susceptible to such rapid changes in its virulence. That hog-cholera bacteria of different degrees of virulence exist in nature had already been demonstrated by inoculation experiments with the bacilli isolated from different outbreaks of that disease. The tenacity with which these bacteria retained the virulence which they possessed at the time of their isolation, when cultivated under ordinary conditions or by passing them through experimental animals, had also been observed. Many efforts had been made to change the virulence of these bacteria, but invariably the results showed that it could not be quickly done by any of the methods employed.‡ The double assurance, therefore,

*Annales de l'Institut Pasteur, IV (1890,) p. 543.

†*Ibid.*, VI (1892), p. 289.

‡*See* Reports of the Bureau of Animal Industry since 1885.

from European investigators that the virulence of the American hog-cholera bacillus could be rapidly increased by passing it through a series of rabbits was somewhat startling. Either to verify their results which appeared at the time to be of much significance, or to acquire additional evidence to support the theory that the virulence of this bacillus is not subject to such artificial changes, an experiment on rabbits was made.

After this experiment was completed it was found that the germ with which Metchnikoff had worked was the bacillus of swine plague * and not of hog cholera, as stated in his article. As he confirmed Selander's experiments, it was not unreasonable to suppose that Selander had made the same error. We have, however, no positive evidence of this, as a culture of his germ has not been studied, and the presumption of an error in the identification of the organism is necessarily based solely on the results he reported and on the statements of Metchnikoff. As the bacillus of the disease in Denmark was described by Selander, † and according to his description it closely resembles the bacillus of hog cholera in form, motility, growth in gelatin, and appearance in animal tissues, it seems unjust to affirm, on the evidence cited, that he had made a mistake in the identification of a germ which he himself had described. On this account his experiment is given that his results may be compared with those obtained in a similar experiment with the bacillus of American hog cholera.

His experiment was made for the purpose of increasing the virulence of the bacteria of *Svinpest* (hog cholera) by passing them through a series of rabbits and pigeons. The germ which he used had been preserved by means of subcultures in gelatin for about two years. It was originally obtained by Selander from an organ of a pig. After this long cultivation it required 1 cc. of a bouillon culture to destroy a rabbit in three days; it would not kill pigeons. With this virus Selander conducted the following experiments:

The spleen of a rabbit which perished in three days from a subcutaneous inoculation with a pure culture was made into an emulsion and a second rabbit inoculated subcutaneously with 1.5 cc. of this emulsion; ‡ a third rabbit was inoculated with a similar quantity of an emulsion made with the spleen of the second rabbit, and a fourth from that of the third. The fourth rabbit died in fourteen hours. Three pigeons were inoculated subcutaneously with 0.1, 0.25 and 0.5 cc., respectively, of the emulsion of the spleen of the fourth rabbit. They perished in fourteen, five, and seven days, respectively. With the blood of the first pigeon, which had been in the incubator for several hours in order that the bacteria could multiply, a fourth pigeon was inoculated (five drops of the blood mixed in a little bouillon was injected); it

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* At Dr. Smith's request Metchnikoff very kindly sent him a culture of the bacillus with which he had worked. It was found to be identical with the swine-plague germ. For a description of this organism see footnote, p. 60, in this publication.

† Centralblatt für Bakteriologie und Parasitenkunde. Bd. III (1888), p. 362.

‡ He does not state how much or what liquid was used to make the emulsion, and consequently the strength of the dose can not be estimated.

perished in thirty-six hours. He continued the passage from pigeon to pigeon until 148 pigeons had been inoculated. The fifth pigeon perished in less than twelve hours. In subsequent cases death occurred in from eighteen to thirty-six hours. Later the irregularities became less and less, and the virulence of the germ fixed, so that a pigeon inoculated at 6 in the evening with from 0.05 to 0.2 cc. of the defibrinated blood of the preceding one would be found dead on the following morning. A very few of the pigeons resisted for a few days. In these, few bacteria were found in the blood, but each exhibited pericarditis with a fibrinous exudate rich in bacteria. The bacteria which were exalted in their virulence for pigeons were also rapidly fatal to rabbits. A subcutaneous inoculation with 0.01 to 0.25 cc. destroyed rabbits in from twelve to fifteen hours, and a rabbit inoculated in the ear vein with 0.05 cc. of virulent blood perished in five hours. The blood from the pigeons was also rapidly fatal to swine. A pig nine weeks old received 0.5 cc. of the blood from pigeon No. 37 in the ear vein at 2 o'clock on the morning of April 3. It was found dead the following day.

It was my purpose to repeat Selander's experiment in every detail in order that a more accurate comparison of the results could be made. A few omissions in the details of his work, however, rendered it impossible to determine certain minor points in his process. The history of the bacillus which I used and the method that was followed in this experiment are appended.

The bacillus was obtained in pure culture from the spleen of a pig which died of hog cholera in La Salle County, Ill., in the fall of 1891. It had been preserved by means of subcultures on agar for about eight months when this experiment was begun. It had not lost its virulence to any appreciable degree. Rabbits inoculated subcutaneously with 0.1 cc. of a fresh bouillon culture would die in from five to eight days. It should be stated that hog-cholera bacteria have rarely been found in the investigations of this laboratory that were sufficiently virulent to destroy rabbits in less than three days when they were inoculated subcutaneously with not more than 0.1 cc. of a fresh bouillon culture. In the preparation of the emulsion from the spleen of the rabbits the following order was observed:

The rabbits usually died during the night. They were examined sometime between 9 and 11 o'clock on the following morning. The spleen was removed very carefully to prevent contamination from without. It was cut into small pieces with sterile scissors and then ground up in a sterilized mortar with 10 cc. of sterile bouillon. Of this emulsion 0.5 cc. was used for each inoculation. Gelatin roll cultures were made from the emulsion in several instances. These developed as many colonies as would usually appear in similar rolls made from fresh (twenty-four-hour) bouillon cultures. The appended table contains all necessary information concerning these inoculations:

Series of inoculations in rabbits with hog-cholera bacteria.

Rabbit number—	Weight of rabbit.	Date of inoculation.	Rabbit inoculated subcutaneously with—	Date of death.	Time rabbit lived after inoculation.	Remarks.
	Grams.				*Days.*	
1	1,482	May 23, 1892	0.25 cc. bouillon culture, hog-cholera bacteria.	May 28	5	Usual hog-cholera lesions.
2	1,482	May 28, 1892	0.5 cc. emulsion spleen, rabbit 1	June 2	4	Ecchymoses beneath pleura and pericardium.
3	1,368	June 2, 1892	0.5 cc. emulsion spleen, rabbit 2	June 7	5	Usual hog-cholera lesions.
4	1,216	June 7, 1892	0.5 cc. emulsion spleen, rabbit 3	June 11	4	Lower colon and duodenum hemorrhagic.
5	1,596	June 11, 1892	0.5 cc. emulsion spleen, rabbit 4	June 18	8	Usual hog-cholera lesions.
6	1,767	June 18, 1892	0.5 cc. emulsion spleen, rabbit 5	June 21	3	Very many coccidia cysts in liver.
7	1,140	June 21, 1892	0.5 cc. emulsion spleen, rabbit 6	June 29	8	Very severe local reaction; punctiform hemorrhages in peritoneum.
8	1,596	June 29, 1892	0.5 cc. emulsion spleen, rabbit 7	July 5	6	Usual hog-cholera lesions.
9	1,672	July 5, 1892	0.5 cc. emulsion spleen, rabbit 8	July 11	6	Do.
10	1,140	July 11, 1892	0.5 cc. emulsion spleen, rabbit 9	July 15	4	Do.
11	1,425	July 15, 1892	0.5 cc. emulsion spleen, rabbit 10	July 22	7	Do.
12	1,596	July 22, 1892	0.5 cc. emulsion spleen, rabbit 11	July 27	5	Do.
13	2,280	July 27, 1892	0.5 cc. emulsion spleen, rabbit 12	Aug. 1	5	Do.
14	1,710	Aug. 1, 1892	0.5 cc. emulsion spleen, rabbit 13	Aug. 6	5	Do.
15	1,425	Aug. 6, 1892	0.5 cc. emulsion spleen, rabbit 14	Aug. 12	6	Do.
16	1,425	Aug. 12, 1892	0.5 cc. emulsion spleen, rabbit 15	Aug. 17	5	Do.
17	2,223	Aug. 17, 1892	0.5 cc. emulsion spleen, rabbit 16	Aug. 24	7	Do.
18	1,824	Aug. 24, 1892	0.5 cc. emulsion spleen, rabbit 17	Aug. 30	6	Spleen unusually small.
19	1,026	Aug. 30, 1892	0.5 cc. emulsion spleen, rabbit 18	Sept. 3	4	Spleen apparently normal.
20	1,710	Sept. 3, 1892	0.5 cc. emulsion spleen, rabbit 19	Sept. 9	6	Usual hog-cholera lesions.
21	1,824	Sept. 9, 1892	0.5 cc. emulsion spleen, rabbit 20	Sept. 14	5	Do.
22	2,280	Sept. 14, 1892	0.5 cc. emulsion spleen, rabbit 21	Sept. 19	5	Do.
23	1,710	Sept. 19, 1892	0.5 cc. emulsion spleen, rabbit 22	Sept. 26	7	Do.
24	1,254	Sept. 26, 1892	0.5 cc. emulsion spleen, rabbit 23	Oct. 1	5	Do.
25	1,311	Oct. 1, 1892	0.5 cc. emulsion spleen, rabbit 24	Oct. 6	5	Do.
26	1,596	Oct. 6, 1892	0.5 cc. emulsion spleen, rabbit 25	Oct. 11	5	Do.

The table shows that a series of inoculations with the hog-cholera bacillus, including 26 rabbits and extending over a period of more than four months time, had no effect whatever in increasing its virulence. In fact, the average time required for the inoculation to kill a rabbit in the first half of the experiment was a trifle shorter than that required with the last ten animals, which indicates a tendency toward attenuation rather than exaltation of the virus. The more rapid death of rabbit No. 6 is explained by the severe invasion of coccidia in the liver. The slight difference in the time required for the inoculation to produce death in the different rabbits can be accounted for on the ground of individual susceptibility or resistance.

Selander's germ was said not to be virulent enough to destroy pigeons, but that the emulsion of the spleen of the fourth rabbit would do so when inoculated in very small quantities. The bacillus of hog cholera which I used in making the rabbit experiment would occasionally kill pigeons when 0.5 cc. of a bouillon culture was injected into the pectoral muscle. This would indicate that his germ was less destruc-

tive to pigeons than the one I employed. However, a series of inoculations in pigeons was attempted in order to complete the comparison and to test the effect on the virulence of the hog-cholera bacillus by passing it through a series of pigeons. That a slight degree of increase in the virulence of the bacillus produced in this way might be detected, a few pigeons were inoculated with a pure culture of the bacillus made directly from the culture from which the first rabbit in the series was inoculated. Pigeons were then inoculated with certain quantities of the emulsion from the spleen of different rabbits in the series, to determine whether the bacillus had become more virulent for pigeons than it was at the beginning of the rabbit experiment. The result of the preliminary inoculations into pigeons is given in the following table:

Inoculation of pigeons with hog-cholera bacteria.

Pigeon number—	Date of inoculation.	Method of inoculation.	Virus used.	Results.
1	May 25, 1892	In pectoral muscle..	0.1 cc. bouillon culture..	Sick; recovered.
2	....do	....do	0.25 cc. bouillon culture.	Died in 22 hours.
3	....do	....do	0.5 cc. bouillon culture..	Died in 36 hours.
4	May 27, 1892	Beneath the skin....	0.25 cc. bouillon culture.	Sick; recovered.
5	....do	....do	0.5 cc. bouillon culture..	Do.
6	June 11, 1892	....do	0.5 cc. emulsion spleen, rabbit No. 4.	Do.
7	....do	....do	0.25 cc. emulsion spleen, rabbit No. 4.	Remained alive; unthrifty.
8	....do	....do	0.1 cc. emulsion spleen, rabbit No. 4.	Do.
9	....do	In pectoral muscle..	0.25 cc. emulsion spleen, rabbit No. 4.	Do.
12	June 20, 1892	....do	0.5 cc. bouillon culture..	Died in 24 hours.
13	June 23, 1892	Beneath the skin....	0.5 cc. blood pigeon 12...	Remained well.
14	....do	....do	0.75 cc. blood pigeon 12..	Died in 4 days.

The uncertainty with which even a large quantity of the culture or emulsion of the spleen of the rabbits, or of the pectoral muscle of the pigeon would kill pigeons, rendered a consecutive series of inoculations impossible. After several efforts to obtain such a series, in which a large number of pigeons were used, the experiment was abandoned. Certain of the pigeons that died from the inoculation were placed in an incubator for from six to twenty-four hours that the hog-cholera bacteria might multiply before the emulsions were made from the pectoral muscle or heart blood, but no additional virulence was obtained. A series of inoculations into the pectoral muscle which was begun with the emulsion of the spleen from rabbit No. 15 gave promise of success, but after a few successful inoculations the virus became contaminated with *Bacillus fluorescens liquefaciens.** The mixed culture was more virulent, but after isolating the bacteria by means of agar plates the hog-cholera bacillus failed to kill pigeons when 0.5 cc. of a bouillon

* The *B. fluorescens liquefaciens* was fatal to pigeons when 0.5 cc. of a fresh bouillon culture was injected into the pectoral muscle. This is the second time that I have found this species of bacteria possessed of pathogenic properties. It is very frequently isolated from diseased animal tissues, the secretions covering the mucous membranes and from various extraneous material.

culture was injected into the pectoral muscle, showing that its virulence had not been appreciably increased.

The results obtained in these series of inoculations are important in demonstrating the constancy of the virulence of the hog-cholera bacillus when treated in this manner. They fully verify the results of more fragmentary experiments heretofore made with this bacillus and show conclusively that the results obtained by Selander do not hold true for American hog-cholera bacteria.

In the preceding article it was shown that by substituting the words swine plague for hog cholera in Metchnikoff's work his results could be verified. In the same article (p. 67) it was found that the swine-plague bacteria obtained from the abscess in the abdominal cavity of rabbit No. 16 were attenuated, but that they were restored to their original virulence by passing them through a series of three rabbits.* In this case, however, the rabbits were inoculated with fresh cultures instead of emulsions from the spleen. This single experiment with virulent swine-plague bacteria, which had become temporarily attenuated by their long life in the abscess, is in harmony with Selander's results. The conditions are also comparable, as his bacillus was at one time virulent, but had become attenuated through long cultivation. It is a significant fact that while he carried on a long series of inoculations his bacillus reached a high degree of virulence in three passages, as the fourth rabbit died in fourteen hours. These results indicate that if we substitute swine plague for hog cholera and *Svinpest* in Selander's article his work also can be verified.

The final and most important conclusion to be drawn from the foregoing experiment is the reply to the question with which it was begun. To this there appears to be but one answer, namely, that the bacillus of hog cholera as encountered in swine can not be rapidly or even slowly increased in virulence by passing it through a series of rabbits.

* In the summer of 1893 a similar series of inoculations were made with the bacillus of rabbit septicæmia, which was obtained from an outbreak of that disease. No appreciable increase in the virulence of the germ was obtained. This bacillus was very attenuated, producing extensive pleuritis and death in from 2 to 4 days after an intravenous inoculation of 0.4 cc. of a fresh bouillon culture. This indicates that even germs belonging to the swine-plague group of bacteria which appear in nature in an attenuated condition are not so susceptible to artificial changes in their virulence as those which appear in a virulent form and are subsequently attenuated.

WHAT BECOMES OF HOG-CHOLERA AND SWINE-PLAGUE BACTERIA INJECTED IN SMALL NUMBERS INTO THE SUBCUTANEOUS TISSUE OF PIGS?

By Veranus A. Moore.

In the investigation of swine diseases it became desirable to determine the extent to which hog-cholera and swine-plague bacteria would be disseminated through the body of pigs when a small quantity of a pure culture of these organisms was injected beneath the skin. It was likewise important to determine the time during which these bacteria would remain alive in the organs of a healthy animal which had been inoculated.

EXPERIMENT WITH HOG-CHOLERA BACTERIA.

In the experiment with the hog-cholera bacillus four well-nourished pigs (Berkshire crosses) two and one-half months old and weighing from 45 to 60 pounds were selected. Two of them received subcutaneously, by means of a hypodermic syringe, on the inside of the right thigh, 1 cc. each, and the other two, 1.5 cc. each, of a bouillon culture of hog-cholera bacteria. The culture used was prepared by inoculating a tube of peptonized bouillon with hog-cholera bacteria and placing it in an incubator for two days, when it was removed and allowed to stand in the laboratory at the room temperature for three days more before it was used. The growth was vigorous and the bacteria still motile. A culture that had grown for five days was employed because in former experiments it had been noticed that a culture increases in virulence up to a certain age.

The pigs were killed at different intervals, and a very careful examination was made of all the organs, excepting the brain. In order to determine approximately the number of bacteria present in the different tissues a gelatin roll culture was made from each. As a check upon the roll culture, a tube of peptonized bouillon was inoculated from the same organs. For the sake of comparison, care was taken to use as nearly as possible the same quantity of tissue for each culture; of the solid organs a piece about the size of a small bean was taken, and of the blood two large loops. The tissues were thoroughly crushed and

broken by means of sterilized forceps. The tissues from which cultures were made from each animal were: the place of inoculation, blood from the heart, lungs, spleen, liver, kidney, lymphatic gland at the smaller curvature of the stomach, and the bronchial gland. Stained cover-glass preparations from the blood and spleen showed no bacteria; those from the local lesions in the first three animals that were killed contained a large number of hog-cholera bacteria, but in those from the fourth no germs could be found. The result of these examinations, together with the history of the inoculations, are summarized in the subjoined table:

Table showing the distribution of hog-cholera bacteria in the organs.

Pig number—	Date of inoculation.	Culture injected subcutaneously.	Pig killed—	Days after the inoculation.	Hog-cholera bacteria in bouillon cultures from—	Number of colonies of hog-cholera bacteria in the gelatin rolls.	Other bacteria in bouillon cultures from—
77	Nov. 3, 1891	*cc.* 1	Nov. 5, 1891	2	Local lesion.....	1,000-2,000	Bronchial gland, blood and liver. *a*
80	....do	1.5	Nov. 10, 1891	7	Local lesion.....	1,000-2,000	Liver. *a*
					Bronchial gland.	20	
					Stomach gland..	50	
78	....do	1.5	Nov. 14, 1891	11	Local lesion.....	1,000-2,000	Bronchial gland.
					Bronchial gland.	No colonies.	
					Stomach gland..	No colonies.	
79	....do	1	Dec. 5, 1891	30	No hog-cholera bacteria.	No colonies....	Bronchial gland.

a A pure culture of an anaërobic, spore-bearing bacillus.

It is of interest to note that the bacteria were not found beyond the place of injection two days after the inoculation, and that in eleven days they did not develop in the gelatin rolls, excepting in the one made from the local lesion. It will be observed, however, that the hog-cholera bacteria were disseminated through the body, for they were detected in certain of the lymphatic glands five and eleven days after they were injected into the subcutaneous tissue. In thirty days they had disappeared from these glands and from the place of inoculation.*

* In the summer of 1893 a somewhat similar experiment was made by Dr. Smith for another purpose, but the results obtained are of interest in this connection. June 5, pig No. 144 was inoculated subcutaneously in the left iliac region with 1 cc. of a bouillon culture of hog-cholera bacteria. A swelling about 6 cm. in diameter developed at the point of inoculation. In the center of this there was a firm indurated nodule about 2 cm. in diameter. The swelling subsided in a few days, but the induration remained as a firm nodule for several weeks. July 8, it was reinoculated on the right side with 1 cc. of a similar culture. The local induration which followed was more severe than after the first inoculation. August 10, the pig was again reinoculated with a similar quantity of the hog-cholera culture. This time a small nodule developed at the point of inoculation. The pig was killed September 12, thirty-three days after the last inoculation, and tubes of bouillon and agar were inoculated with pieces of the local induration caused by the last inoculation, and with pieces of the liver. These remained clear, and cover-glass preparations made from the local induration showed no bacteria.

It is an interesting fact that in no case hog-cholera bacteria were found in the blood, spleen, liver, or kidneys, where they are almost invariably detected when the animals perish from hog cholera contracted either by exposure to the disease or by inoculation. It is unfortunate that a few additional cases could not have been added between the third and the fourth animal so that the time of the disappearance of the germs could have been more exactly determined.*

These inoculations demonstrate the fact that when hog-cholera bacteria are injected in small numbers they are taken to different parts of the body and harbored for a considerable time in certain lymphatic glands as well as in the subcutaneous tissue at the place where they were injected, and that eventually they are destroyed. There is very little, if any evidence, that the bacteria multiplied to any great extent within the animal body. The swelling at the place of inoculation can not be attributed solely to this cause, as injections of sterilized cultures have frequently been found to produce severe local reaction.

The other bacteria obtained from the bronchial glands were ordinary aërobic saprophytic organisms; the same is true of the germ found in the blood of pig No. 77. The anaërobic spore-bearing bacillus obtained from the liver of pigs Nos. 77 and 80 probably belonged to the group of bacteria containing *Bacillus butyricus*. It grew only in the bottom of bouillon tubes and died out after the second subculture was made.

The animals were killed by a blow on the head. This may account for the presence of bacteria in the blood of pig No. 77, as this animal lived some minutes after the blow was administered, giving the blood a chance to carry bacteria from the injured parts. The examination showed no lesions due to the injection of the virus, excepting a local swelling,† and at no time did the pigs show any ill effect from the injection of the bacteria. The local reaction as shown by the post mortem was somewhat variable, owing to the difference in the time of death after the inoculation.

A rabbit was inoculated subcutaneously with 0.1 cc. of the bouillon

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*The considerable number of colonies of hog-cholera bacteria that developed in the roll cultures made from the lymphatic glands after five days, and their absence in the gelatin rolls made from the glands after eleven days had elapsed, indicate that the destruction of the bacteria in the lymphatics was nearly completed in that time.

† In pig No. 77 there was a purulent infiltration and thickening of the subcutis extending over an area 5 by 3 cm. In pig No. 80 the subcutis was thickened, quite firm and apparently necrosed over an area 8 by 2 cm. In pig No. 78 there was a quite firm tumor about 6 by 2 cm. underneath the skin. The exterior layer of the tumor was of a pale, pinkish, translucent appearance, while the interior was firm and whitish, due to a dense infiltration of leucocytes. It was attached to the subjacent muscle by loose connective tissue. In pig No. 79 there was a scar at the point of injection beneath which was a layer of purulent substance about 2 mm. thick, and extending over an area about 5 cm. in diameter. Around this the connective tissue was slightly thickened.

culture from the bronchial gland of pig No. 80. It died of hog cholera on the fourth day.

EXPERIMENT WITH SWINE-PLAGUE BACTERIA.

The experiment with swine-plague bacteria was carried out in a manner similar to the one with hog cholera just described. A few differences in the details, however, should be mentioned. Two pigs were selected from the same herd as those taken for the previous experiment. They were inoculated subcutaneously in the right thigh with 1 cc. each, of a turbid suspension in bouillon of the surface growth from an agar culture of swine-plague bacteria one day old.* As the swine-plague bacillus grew very unsatisfactorily in gelatin the cultures from the various organs were made on the inclined surface of agar and in bouillon. In other respects the details were the same as those already described in the experiment with hog-cholera bacteria. A summary of the inoculations and the result of the bacteriological examination of the various organs is given in the subjoined table:

Table showing the distribution of the swine-plague bacteria in the tissues.

Pig number—	Date of inoculation.	Bacteria injected subcutaneously.	Pig killed—	Days after inoculation.	Swine-plague bacteria in cultures from.	Colonies of swine plague on surface of agar.	Other bacteria in cultures from.
85	Nov. 14, 1891	1 cc. suspension agar cultures.	Nov. 16	2	Local lesion only.	So numerous as to be confluent.	Kidney. Bronchial glands and lung.
81	....do	....do	Nov. 20	6	....do	....do............	Bronchial gland and liver.[1]

[1] Anaërobic spore-bearing bacillus.

From this experiment it is evident that the swine-plague bacteria were either not disseminated through the body, as in case of the hog-cholera bacilli, or that being taken up they were destroyed more rapidly than were the hog-cholera bacteria.

There were no disturbances produced by the inoculations, and the post-mortem examinations revealed no lesions that were produced by the injections, excepting the local reaction. This varied somewhat: in pig No. 85 there was a thickening of the subcutaneous tissue about the point of injection extending over an area 4 cm. in diameter; the subjacent muscle was roughened; considerable blood extravasation in the thigh muscle. In pig No. 81 there was a small (1.5 cm. in diameter) tumor beneath the skin at the place of inoculation consisting of a soft. grayish nucleus surrounded by a quite firm connective tissue wall.

From the cultures and cover-glass preparations it was impossible to determine whether there was any difference in the number of bacteria

*It should be noted that the turbid suspension from the agar cultures of the swine-plague bacteria injected was equivalent to a much larger quantity of a simple bouillon culture so far as the number of bacteria is concerned.

in the local lesion of the two animals produced by the injection of the bacteria. The tubes of agar inoculated developed confluent growths, and in stained cover-glass preparations no bacteria could be detected in either case. It is presumable that there was at most only a slight multiplication of the bacteria in the subcutaneous tissue. This is indicated by the somewhat diffuse lesion in the pig killed in two days and the formation of a circumscribed tumor at the seat of inoculation in the animal that was allowed to live six days.

The identity of the bacillus obtained from the local lesion of pig No. 81 was established by inoculating a rabbit with a very small quantity of the culture. It was found dead on the following morning and its organs contained innumerable swine-plague bacteria. The spore-bearing bacillus found in the bouillon culture from the liver of pig No. 81 was apparently identical with those found in cultures from the livers of pigs Nos. 77 and 80.

It is instructive to note that in 5 of the 6 pigs used in these experiments the bronchial gland was found to be infected with various species of bacteria. This fact is valuable as it demonstrates that bacteria may be carried through the lungs into the corresponding lymphatic glands.

From these experiments the following conclusions appear to be warranted concerning the fate of these bacteria when injected subcutaneously in small numbers.

1. Both hog-cholera and swine-plague bacteria will remain alive in the subcutaneous tissue for several days after their injection.

2. The hog-cholera bacteria are taken up from the point of injection and distributed, to a certain extent, through the body. They are harbored for a limited period of time in certain lymphatic glands where they may be detected. They are not found in the other organs of the body.

3. The swine-plague bacteria are not found beyond the tissues immediately surrounding the point of their injection.

4. Subcutaneous injection of small doses of either hog-cholera or swine-plague bacteria of ordinary virulence have little, if any, pathogenic effect.

PRACTICAL BEARING OF THE PRECEDING INVESTIGATIONS.

By Theobald Smith.

The experience of the past fifteen years has amply shown that all facts concerning the nature of important disease germs, however insignificant they may appear by themselves, should be worked out and recorded. Slight variations or modifications of such potent organisms may express themselves in the shape of extensive epidemics and epizoötics, for it seems to require but a slight elevation in the virulence of any pathogenic organism to greatly extend its injurious operations. The careful study of the hog-cholera group of bacteria is thus a matter of necessity. Thus far we have found a well-defined bacillus associated with outbreaks of hog cholera in a considerable number of localities, both in the East and the West. The relation of this bacillus to the disease is unquestioned. Furthermore, this bacillus occurs under a number of varieties, whose chief distinguishing character lies in the varying degree of pathogenic activity. Some are more, others less virulent, and the type of disease produced in swine is correspondingly varied. The outbreak from which a few cases are reported in full on page 27, and from which a well-defined variety was isolated, differs in important particulars from other types of uncomplicated hog cholera in the greater duration of the disease and the peculiar diphtheritic character of the inflammation of the intestines. The confusion existing even to-day in the minds of many authorities on the subject of swine diseases, expressing itself in the multitudinous names which have been given to them, evidently rests in part on the different types which hog cholera assumes as a consequence of the pathogenic variability of the bacillus.*

Besides those varieties of this bacillus actually encountered in swine diseases there are other more or less closely related varieties of this species or group of species which have been found in connection with disease among other domestic animals.

In Bulletin No. 3 I described a bacillus from the vagina of a mare after abortion, which certainly is a hog-cholera bacillus. In Europe, Gærtner found a bacillus in the organs of a sick cow, the meat of which

*In the bulletin on Swine plague (1891) a study of the varieties of the swine-plague bacillus will be found.

caused a widespread epidemic of gastro-intestinal disease in man. In the foregoing pages I have recorded facts which show that this bacillus is hardly more than a variety of the hog-cholera bacillus. The same may be said of the mouse-typhus bacillus of Loeffler, which the discoverer has recommended and used in the destruction of field mice and other pests.* In the observations given in the preceding pages this organism is shown to possess pathogenic properties of a high degree, but differing somewhat from those possessed by the true hog-cholera bacillus.

Both these organisms were found in Germany, yet there is no positive evidence that hog cholera exists there. It is true that neither organism is completely identical with the virulent hog-cholera bacillus as found in this country, yet they approach quite closely the less pathogenic varieties. This leads us to the broad question whether the different methods of rearing and feeding swine have led in the one country to a repression of such diseases, and in the other to an extension of them by reducing the resistance of the digestive organs of swine. The cultivation of the hog-cholera bacillus by the continuous existence of the disease may have finally led with us to races of maximum virulence.

Intimately associated with the problem of variations in this group is the one dealing with the possible extension of hog cholera to other domestic animals. This must be constantly kept in view, and attention has already been called to this phase of the hog-cholera problem in Bulletin No. 3. Thus far members of this group have been found in a cow, in mice, and in a mare after abortion. Even if the hog-cholera bacillus may not at present produce epizoötics in other animals, the possibility is open that it may produce various disturbances in isolated cases, that it may act with other disease germs, and, finally, that it may slowly adapt itself to other species.

This adaptation must be a slow process, for the foregoing investigations show how tenacious the characters of the hog-cholera bacillus are and how difficult it is to modify its virulence, either by methods of cultivation or passage through animals. This fact, which has been brought out in various ways in former investigations, has been confirmed by the inoculation experiments reported by Dr. Moore on page 100. This species is, on the whole, very stable, and its very stability is responsible for its dangerous properties by putting obstacles in the way of preventive inoculation, disinfection, and the recovery of diseased animals.

In carrying on vaccination experiments on the smaller experimental animals we were guided by the fact that the problem of immunity is to-day the foremost one in the more abstruse study of infectious diseases, and that its ultimate solution will furnish efficient practical ideas concerning those causes which predispose animals to infection. The study of any one infectious disease will not lead us very far. A num-

* Annual Report of the Secretary of Agriculture for 1893.

ber of different maladies must be thoroughly exploited. For us the immediate task appears to be the investigation of the problem in connection with those animal diseases which are of the greatest economic importance and about which we had gathered together much information. In other countries the same problems have been attacked in connection with other diseases, and by mutual coöperation much advantage has accrued. In the experiments reported in these pages some important facts have been disclosed. We have learned that swine, as a rule, are not very susceptible to either disease. This is proven by the difficulty of producing disease either by feeding cultures or by injecting them under the skin. It is also shown by the nature of the diseases as they manifest themselves in swine. They are always localized in one or more organs, while in the very susceptible small animals both diseases appear as generalized septicæmic diseases of a speedily fatal character and are produced by inoculation with exceedingly minute doses. If swine therefore already possess a fair degree of immunity against these diseases we must look for accessory causes to account for the extensive mortality. Those conditions which favor an unhealthy condition such as monotonous, badly chosen food rations and animal parasites, especially lung worms and ascarides, have already been discussed in the bulletin on swine plague, as possible agents in breaking down those protective barriers to disease which in the swine diseases consist mainly in perfect digestion and healthy lungs. Swine should receive at least some of the attention and care that is given to other domestic animals, and sanitary laws can not be set aside without inviting disease germs to enter the system. It is taken for granted that proper precautions are to be taken at all times to prevent the introduction of sick or exposed animals into a herd, but there may be regions where the surroundings, the soil, and the water courses are being so continually infected that the disease germs may be presumed to be present at all times, and where the only safeguards against infection will be a proper amount of attention to the general health of the animals and to the removal of those conditions which are likely to impair it.

How important a part the food plays in predisposing animals to hog cholera and swine plague has not thus far been studied. Certain it is that such one-sided food as corn and water can not be recommended. It has been shown that when rats are fed on a flesh diet they are more likely to resist anthrax after inoculation than when fed on bread.* When those fed on bread also received salt, increased resistance was likewise observed. A reduction in the necessary quantity of proteid food with swine may perhaps be responsible for more injury than appears on the surface. Errors in feeding are not likely to limit their injurious activity to one disease alone but may increase susceptibility to disease in various directions. Improper food besides reducing the general resistance of the body cells to bacterial invasion may lead to

*Kurt Müller: Der Milzbrand der Ratten. Fortschritte der Medicin, 1893, p. 522.

a weakening of certain important organs such as the stomach. It has been frequently shown how important normal digestion is for the prompt destruction of bacteria in the food. A catarrhal condition inducing a less acid reaction of the mucous membrane may permit hog-cholera bacteria to pass through this organ alive and once in the small intestine they will invariably set up disease.

Our experiments have furthermore shown that the different degrees of susceptibility may produce quite a variation in the character of the disease, and that when a certain degree of immunity has been produced in rabbits it would be impossible to foretell what form the inoculation disease would assume. It might become localized in the intestines or the lungs, or even in the brain. Swine plague might appear as a peritonitis or a pleuritis with or without pneumonia, or in the form of one or more abscesses. This interesting fact is at present of most service to the investigator, because he will be better able to identify obscure diseases. It is needless to insist on the importance of this knowledge. The presence of mild, chronic hog cholera or swine plague in a herd may be fully as dangerous as the more acute disease, for mild disease is frequently caused by highly virulent bacteria. This has been fully brought out in the foregoing pages. Rabbits which, through vaccination, have lived many months after inoculation have continued to carry disease germs in their body virulent enough to kill unvaccinated rabbits in twenty hours.

Another fact of considerable importance is the relative character of the immunity produced by vaccination. An animal which before preventive inoculation possessed a high degree of susceptibility may after treatment no longer contract an acute rapidly fatal disease but one of a more chronic character, which dragging itself along for months and rendering the animal worthless may form the starting point of subsequent outbreaks among newly introduced or younger animals. This state of affairs has been noticed in Europe after vaccination against rouget, or swine erysipelas, a disease of swine thus far not found in this country.* While it is not of sufficient importance to militate against the use of successful vaccines, it should nevertheless not be lost sight of in a final estimate of the value of vaccination methods as a whole. Our observations on hog cholera lead me to believe that even if a fairly successful and cheap method of vaccination against hog cholera could be devised the result would be that a number of animals would contract a chronic type of the disease after infection, and these would have all the objectionable features of worthless animals scattering infection about for months.

In all efforts directed towards the production of a certain refractory state of the animal body towards certain disease germs, in other words, in all attempts at preventive inoculation, we must bear in mind that the effort expended is in direct proportion to the gravity of the diease

* *See* p. 91.

to be fought. This is very well illustrated in the experiments on rabbits and guinea-pigs. Only with great difficulty are these animals made refractory to inoculation with hog-cholera bacilli, while it is comparatively easy to induce a high degree of immunity towards swine-plague bacteria. In all experiments with living cultures or the products of cultures there is a retardation of growth of the vaccinated animal and even a loss of weight, which is the more pronounced the more thorough the preventive treatment. The most successful processes are also the most trying to the animal system. The apparently entirely harmless method of injecting the blood serum of immunized animals suffers from two disadvantages—the immunity is said to be transient unless the treatment is followed by an injection of living cultures, and the difficulties of obtaining the blood serum are considerable. In all methods of preventive inoculation, we must reckon with the cost, which should include the loss in weight and thriftiness sustained by the animals. It is safe to assume that any method which claims to produce immunity towards an infectious disease of a serious character with but little expense or injury of any kind should be looked upon with grave suspicion, for the energy required to bring the animal into the refractory state must on general principles balance or overcome the energy exerted by the disease germs on the unprotected animal organism.

That serious diseases of a slowly progressive character can not be cured or prevented by simple means has been amply demonstrated during the past few years by the history of tuberculin. At first supposed to act as a remarkably rapid cure for human tuberculosis, it is now considered of service only in the earliest stages of this disease. Even here its efficiency is brought out only by prolonged use in minute doses and combined with climatic treatment. It is thus shown that the energy expended in curing early cases is certainly very great, and when applied to animal life wholly out of proportion to the value of the animal, even if a cure could be effected. The same principle is applicable to preventive inoculation, with this difference, that it is very much easier to prevent disease than to cure it. The rapidly fatal diseases known as blood diseases or septicæmias seem to be more easily amenable to preventive inoculation. But even as to these (anthrax, rouget), opinions among authorities are divided, and it has been difficult to obtain any trustworthy data. It has already been stated that a chronic, eventually fatal, form of rouget may appear as a result of the vaccination or as a result of infection after vaccination. Hence, all cases of death among vaccinated animals should be carefully studied before any trustworthy knowledge of the effect of vaccines can be obtained.

Bringing all the facts brought out by the swine investigations together, we would suggest that more attention be paid to the collateral causes which contribute to fatality among swine. These collateral causes necessarily change with the climate, the food, and the manner of keeping such animals, and can be investigated only when the diseases pre-

vail. More attention should be paid to the effect of food, both in predisposing to hog cholera and swine plague and in producing diseases of the digestive organs which simulate hog cholera, but which are probably quite easily prevented. A thorough study should also be made of lung worms and ascarides. If these difficulties can be removed or mitigated, and if the diseases due directly to improper feeding be eliminated by more careful attention to fundamental principles, it is more than probable that the infectious swine diseases will largely disappear. This prediction is based on the fact, experimentally determined and already referred to, that swine naturally possess more or less immunity towards both hog-cholera and swine-plague bacteria, and that with vigorous digestion and sound lungs they may be able to resist the infection which can reach them in decently kept surroundings. We do not intend to deny the possibility that now and then highly virulent races of pathogenic bacteria appear, which are reported to sweep everything before them. These we have still to find. In the field our usual experience has been to find obscure diseases not definitely traceable to any disease germ, or else very chronic cases of hog cholera and swine plague. I would therefore urgently recommend a more extensive study of swine diseases in the field, which should include in its scope all causes of disease. Only by such investigations can we hope to determine the various agencies actually at work in different sections of our country in destroying swine, and to estimate more accurately the losses due to pure infection, to animal parasites, and to improper feeding.

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United States Department of Agriculture,
BUREAU OF ANIMAL INDUSTRY—Circular No. 43.
D. E. Salmon, D. V. M., Chief of Bureau.

WASHINGTON, D. C., *February 12, 1904.*

SIR: Last October this Bureau published, with your approval, Circular No. 41, entitled "A form of hog cholera not caused by the hog cholera bacillus," in which it was stated that there is in this country an infectious disease among hogs which may be reproduced by infecting with material containing no hog cholera bacilli. It was also stated in that circular that the experiments along this line were not yet completed, and this is still the situation; but it is deemed wise to offer for publication a few additional notes on this disease which have been prepared in the Biochemic Division of this Bureau. I therefore recommend that the manuscript herewith transmitted be published as Circular No. 43 of the Bureau of Animal Industry.

Respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

IMMUNIZATION FROM HOG CHOLERA.

On October 1, 1903, this Bureau published as Circular No. 41 a preliminary note on some new facts in regard to the etiology of hog cholera. As experiments in this line and also in methods of producing immunity from this disease have been in progress for some years, it seems that, in view of the results, the important points of the investigations should be published, so that the State experiment stations and others, if they so desire, may make experiments on a large scale along the lines of work which have proved most successful.

The underlying principle of the entire work, which has been carefully studied by de Schweinitz and Dorset, of the Biochemic Division, has already been indicated in Circular No. 41. They have had charge of the general plan of the work and proposed the use of blood from diseased and immunized animals. The practical inoculations and autopsies at the Experiment Station of the Bureau have been carried out under the supervision of Dr. E. C. Schroeder, who also made, at the request of the Chief of the Bureau, some immunity experiments with dried diseased blood. The work in Iowa has been in charge of Dr. W. B. Niles.

On account of the often discordant results which were secured some years ago when the Bureau was treating diseased hogs with serum from animals which in their turn had received large and repeated doses of hog cholera and swine plague cultures, it appeared that some other

factor must be considered in the efforts to produce immunity. The first suggestion of de Schweinitz was that some parasite of the hog, such as the louse, should be studied. This was carefully done, but the results obtained were such as to make it appear that, while a louse might under certain conditions convey disease from a sick to a healthy animal, it was not the important agent in spreading so-called hog cholera.

A large number of specimens of blood from sick and healthy hogs were also examined, and while very small, peculiar, round bodies were found both inside and outside of the corpuscle, and sometimes bodies with distinct amœboid movement were noted, the relation, if any existed, of these bodies to the disease could not be determined satisfactorily. It was noted, however, that in cases of so-called hog cholera the disease could be readily conveyed from a sick animal to a healthy one by giving the latter a subcutaneous injection of the blood serum or defibrinated blood obtained from the former. It was found that a small fraction of a cubic centimeter would produce the disease, though we have in most of our experiments fixed 1 cubic centimeter as the most satisfactory dose for use. As has been indicated by de Schweinitz and Dorset in Circular No. 41, blood from a diseased animal which was passed through the finest Berkefeld or Chamberland filter produced in hogs the typical disease. This blood had been proved to be free from microorganisms detectable by the ordinary bacteriological methods, or by the inoculation of small animals, such as the guinea pig or rabbit, which are known to be very susceptible to the ordinary hog-cholera bacillus. It appeared, therefore, that immunity could be produced by the use of blood in which the disease-producing property had been attenuated or partially neutralized. The experiments have well established the fact, which is also true of the so-called hog cholera, that animals once immunized against this disease will resist repeated large doses of disease-producing blood and also subsequent exposure to diseased hogs in the field.

The basis of the immunity experiments, therefore, has been the use of attenuated and disease-producing liquid or dried blood, or the use of this blood mixed with blood obtained from immune animals, in which animals the immunity has been increased by the injection of large doses of disease-producing blood obtained from hogs known to have the disease; or, in other words, disease-producing blood and antitoxic blood separate and combined have been successfully used.

In order to test the immunity of the treated animals, they were eithe exposed by inoculating them with known disease-producing blood or b placing them in the field or pen with sick animals.

The previous work of this Bureau has shown very clearly that anima immune from hog cholera are not necessarily immune from swi

plague, or vice versa, and, furthermore, that many different diseases may at times be mistaken for hog cholera. In making practical exposure tests, therefore, it is absolutely necessary to prove the character of the disease by careful autopsies and by the use of a large number of checks, which checks should succumb to the disease in order to prove the positive virulence of the exposure.

Although we are still trying the experiments on a large scale and will continue them during the coming summer, before recommending the details of a plan for practical adoption, we feel that these results of the extensive and laborious experiments, which have been carried on by the Bureau for a number of years, should be presented now in this concrete form, as it will require a number of months to prepare the detailed reports of the experiments for publication.

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U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY—BULLETIN NO. 47.

D. E. SALMON, D. V. M., Chief of Bureau.

THE HOG INDUSTRY.

SELECTION, FEEDING, AND MANAGEMENT.
RECENT AMERICAN EXPERIMENTAL WORK.
STATISTICS OF PRODUCTION AND TRADE.

BY

GEORGE M. ROMMEL, B. S. A.,
EXPERT IN ANIMAL HUSBANDRY, BUREAU OF ANIMAL INDUSTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 29, 1903.

Sir: I have the honor to transmit herewith the manuscript of an article entitled The Hog Industry: Selection, Feeding, and Management; Recent American Experimental Work; and Statistics of Production and Trade, by George M. Rommel, expert in animal husbandry, and to recommend the publication of the same as Bulletin No. 47 of this Bureau. In the compilation of the portion relating to American experimental work Mr. Rommel has consulted with Dr. C. F. Langworthy, of the Office of Experiment Stations, and in the preparation of that portion relating to statistics of production and trade in hogs, with the chief of the Bureau of Statistics, and for the valuable assistance thus obtained I desire to make acknowledgment. Our thanks are due Prof. Charles F. Curtiss, Director of the Iowa Experiment Station, for assistance.

The bulletin is a very comprehensive one, covering every phase of the subject, and it will be useful, it is believed, to the large number of persons engaged in the industry mentioned.

Respectfully,

D. E. Salmon,
Chief of Bureau.

Hon. James Wilson, *Secretary.*

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THE HOG INDUSTRY.

By George M. Rommel, B. S. A.,
Expert in Animal Husbandry, Bureau of Animal Industry.

SELECTION, FEEDING, AND MANAGEMENT.

The hog has always occupied an important place in the animal husbandry of the United States. Unlike the supply of breeds of other kinds of live stock, the main dependence of American farmers for hogs has been placed upon breeds that have been developed on American soil. With a large native stock at hand, by selecting and feeding, blending strains and molding forms, American farmers may be said to have done for hogs what English farmers have done for the breeds of beef cattle and mutton sheep. Five distinct breeds have originated within that section of the country where corn is notably a feature in farming, viz, the Chester White in Pennsylvania, the Duroc Jersey in New Jersey and New York, the Poland China in Ohio and Illinois, the Victoria in New York and Indiana, and the Cheshire in New York. From the localities of their origin these breeds have been gradually disseminated over the entire country, the Poland China and Duroc Jersey having perhaps the widest distribution.

Coincident with the development of native breeds, the leading English breeds, particularly the Berkshire, have come into more or less popularity. The Berkshire has here the largest representation of foreign breeds, and are very nearly, if not quite, as generally distributed as the Poland China. With it have come the Essex (called Small Black, or Suffolk, in England),[a] the Large, Medium, and Small Yorkshire (generally called Large White, Middle White, and Small White in England),[b] and the Tamworth. A strain of white pigs known as Suffolks is somewhat general in this country, but good authorities consider it merely the Middle Yorkshire under another name. The real Suffolk pig is our Essex, in whose development Lord Western and Fisher Hobbs had so strong an influence.

[a] Spencer. Pigs: Breeds and Management, p. 15. [b] Idem, p. 5.

CONDITIONS SUITABLE FOR HOG RAISING.

The climate and soil which will best favor the production of any kind of live stock are those in which the same kind of stock is found wild. In his native state the hog frequents those localities where vegetation is abundant if not luxuriant. The climate is usually one of only moderate severity. If extremes either of heat or cold are common, the environment provides shelter in the dense thickets in winter and shade and an abundance of water in summer. He is a heavy and promiscuous feeder, and, therefore, in his domestic state he thrives best where pastures are most luxuriant and grain crops, nuts, or roots are most abundant. The hog is not a ranger, nor does he thrive on grass alone; he can not endure a great amount of travel at a time; exercise he must have, yet he must be able to find his feed with only a small amount of searching, and water should always be easily accessible. During hot weather he craves a pool of water to reduce his temperature, for he perspires little; and in winter he wants shelter from storms. Owing to these requirements there are few hogs in the semiarid States of the West, and in that section hog raising is coincident with irrigation and alfalfa growing.

The first place in hog raising in the United States is easily with the corn-growing sections, and here corn is the first grain thought of when the fattening of animals, especially hogs, is mentioned. It is, however, fallacious to argue that hog feeding will not give profitable returns outside of the corn belt. The corn belt has wonderful advantages for economical pork production, but it also has its disadvantages, one of which is the effect on fecundity of feeding too much corn to breeding stock. Any locality that will grow clover of any species, that is favorable to the production of alfalfa, peas, or beans, where grains are readily grown—not only corn, but barley, wheat, oats, or rye—will be a favorable situation for the successful production of pork. If it is a locality where dairying is common, no better advantages are required; for, given leguminous pasture—clover, alfalfa, peas, beans, etc.—as a basis, with a grain feed that can be readily grown and also dairy by-products, the very highest grade of pork can be produced at a minimum cost. Variety of feeds alone is an item of immense importance in feeding. An animal tires of a constant ration of one kind, and is more easily put "off feed" at such times than when he is occasionally supplied with a change to keep his appetite keen. Not only has variety of feed an influence on appetite, but it results in a better quality of pork.

The few States comprising the corn belt are in reality the source of supply for a great amount of the meat product, especially hams and bacon, that is consumed in other portions of the country. Yet the advantages of many of these corn-belt States are little, if at all, superior to those outside of that district. The South has an abundance of vegetation. Cowpeas, velvet beans, and peanuts are leguminous

crops that are peculiar to that section. Corn grows readily in all parts of the South, and in the subtropical portions the experience of feeders with cassava seems to indicate that it has considerable value for pork production. In addition, there is generally an abundant water supply; the climate is mild, and there is a long period during which green feed is available; the expense of shelter and winter feeding is very greatly lessened. These conditions, giving a long period of pasture and outdoor life, enhance thrift, and, with proper management, insure great freedom from disease.

In the extreme West the alfalfa of the irrigated valleys and the clover of the coast districts give a splendid foundation for successful pork production. In most of these regions there is an abundance of small grain, particularly barley, that may often be fed economically, while in some localities corn is a successful crop.

Barley is of so much interest to the experimenter, and its use is of so great importance in the production of prime pork, that it demands more than a passing notice. This grain has not been relied upon to a great extent in America as the principal part of a hog-fattening ration, but the practice of Danish farmers and the results of experiments can very well be studied with profit by American feeders. The Danish bacon, which figures so prominently in the English markets, is produced mainly with barley and dairy by-products. At the Ontario Agricultural College, Day has found barley so valuable in the production of prime export bacon that it is now used as a standard with which other grains are compared. In his experiments to determine the nature and causes of "soft" pork, Shutt found that the best bacon produced was by a ration in which barley was at least one-third of the whole amount. Farmers in those parts of the country where barley is a prominent crop can well devote attention to their opportunities for pork production; besides, in addition to this grain, some of the leguminous crops can often be grown for pasture, thus furnishing materials for a well-balanced ration.

The grain-growing districts of eastern Oregon and eastern Washington are instances of such localities. Corn is raised there to a very limited extent, but barley is an abundant crop and can be produced at minimum cost, and often wheat may be utilized. In nearly all parts of this section there are irrigated valleys where alfalfa grows abundantly. Yet every town and city in this section imports immense quantities of pork products from the corn belt; indeed, it has been stated that 75 to 90 per cent of all the hams and bacon sold at Spokane are shipped in from the East; and when one remembers that this city feeds a very great territory it is readily seen how great is the dependence on the corn belt.

The purpose of these remarks is not to minimize the value of corn in meat production of any kind. Corn is, perhaps, with a favorable climate and soil, the most economical grain that is at the command of the stock raiser and feeder of the United States. It is nutritious and

highly palatable. Without its use it is difficult to imagine how the animal products of the United States could have attained their present position in the world's commerce; and so long as meat products are a factor of American agriculture, corn will probably be a leading factor in meat production in this country, and the corn belt will naturally continue to be more or less the center of feeding operations. On the other hand, the condition is ever present that farmers in localities where corn is a limited product have their own wants to supply. If, in addition to their own needs, the farmers of these localities can supply a share of the export demand, great strides will have been taken in their agricultural development; for "live-stock husbandry is the foundation of successful agriculture." A market for the surplus is, of course, essential, but where a supply is available the market will probably grow up. The condition of the meat trade at present indicates that a strong market is assured for a very considerable time to come. The statistics presented herein show generally an increased trade both at home and abroad. The domestic consumption of all kinds of meats seems to be increasing, although the per capita amount can not be shown with accuracy. There is little reason to fear that the further development of the pork-producing interests of the United States will soon result in overproduction.

THE PROFITABLENESS OF HOG RAISING.

FECUNDITY.

The first feature of hog raising that appeals to farmers is the fecundity of the sows. No other meat-producing domestic animal, after poultry, is capable of producing so large a number of young in a year. The size of litters varies with breeds and with location and feed.

One of the effects of high corn feeding on breeding stock is the lessening of prepotency and fecundity. When the conditions of forage furnish a more or less varied diet, and consequently a better balanced ration, high fecundity may be expected. Free access to pasture will therefore always be a good practice with breeding sows. In addition to this, the number of hogs may almost be doubled by breeding the sows so as to produce two litters a year. The practice demands considerably more care on the part of the breeder than when breeding but once a year, and it should not be attempted unless the needed attention can be given at farrowing.

CHEAPNESS OF PRODUCTION.

Lawes and Gilbert[a] were the first investigators to make accurate determinations of the relative economy of meat production from the

[a] "On the composition of oxen, sheep, and pigs, and their increase whilst fattening," pp. 53–54.

various domestic animals. The summary of their studies on this subject is as follows:

(1) Fattening oxen, fed liberally upon good food, composed of a moderate proportion of cake and corn, some hay or straw chaff, with roots or other succulent food, and well managed, will on the average consume from 12 to 13 pounds of the dry substance of such mixed food per 100 pounds live weight per week, and should give 1 pound of increase for 12 to 13 pounds of dry substance so consumed. Sheep fattening under somewhat similar circumstances, but with a less proportion of hay and straw, will consume about 15 pounds of the dry substance of the mixed foods per 100 pounds live weight per week, and should yield, over a considerable period of time, 1 part of increase in live weight for about 9 parts of the dry substance of their food. If the food be of good quality, oxen and sheep may give a maximum amount of increase for a given amount of total dry substance of food, even provided the latter contain as much as 5 parts of total nonnitrogenous to 1 of nitrogenous compound.

(2) Pigs fed liberally upon foods composed chiefly of corn will consume from 26 to 30 pounds per 100 pounds live weight per week of the dry substance of such food. They should yield 1 part of increase in live weight for 4 to 5 parts of the dry substance of the food. They may give a maximum amount of increase for a given amount of dry substance of such food if it contain as much as 5 or even 6 parts of total nonnitrogenous to 1 of nitrogenous compounds.

These results have been corroborated repeatedly by American experimenters.

In their dressed weight hogs show less variation than cattle and about the same as sheep. The range between young pigs or poorly fattened animals and mature, finished hogs will be about 8 per cent—approximately 74 to 82 per cent of the live weight; with cattle the range is at least 15 per cent, between 55 per cent in the lowest returns of ordinary market animals and the high records of 70 per cent and over with stock-show winners. Sheep will vary approximately, depending on the age and condition, from 48 to 60 per cent.

HOGS AS SCAVENGERS.

The third benefit to be derived by the farmer from raising hogs comes from their eating waste products that would otherwise become a nuisance. Kitchen slops, the screenings from fanning mills, and the waste from thrashing machines can all be utilized in the pig yard; while the use of hogs in connection with beef production is frequently regarded by feeders as the principal source of profit. If hogs are raised in connection with dairying, pork of the highest quality may be produced. Dairy by-products (skim milk, buttermilk, and whey) agree with hogs especially well. Skim milk is especially valuable for pigs before weaning and during the earlier stages of feeding

after they are weaned. Its value with breeding stock is also very great. Whey is also valuable, though not so much so as skim milk. It should be fed carefully, for large amounts given continuously will cause a sort of rheumatic lameness in pigs.

Care must be taken in using hogs as scavengers. A good deal of stuff that finds its way to the hog lot should go to the garbage bank. Deleterious substances, such as lye, soap, glass, nails, etc., are very frequently in city swill, and such swill has been known to prove fatal when fed.

HOUSES, INCLOSURES, AND FENCES.

THE HOUSE AND ITS LOCATION.

Hogs are notably affected by extremes of heat and cold, and the character of their shelter will therefore depend on the locality. If the locality is one of severe winters, warm quarters are a necessity and an extensive piggery may be erected. Four things should be especially considered in its construction—(1) light, (2) ventilation, (3) warmth, and (4) cleanliness. Under cleanliness, ease of cleaning and dryness must be regarded. A well-drained location should be chosen. One that will give the hogs a good climb to reach it will provide needed exercise. The house should be on a north-and-south line, so that both sides may receive direct sunlight during a part of the day. Mr. John Cownie, of Iowa, recommends a house with a wide driveway, with pens 6 or 8 feet square on either side opening into the driveway, and each pen provided with a window for light and ventilation.[a] Mr. L. N. Bonham, of Ohio, recommends a house with a row of sleeping pens on either side of a cement-floored alley, opening into feed pens floored with cement. The sleeping pens are floored with boards laid in gravel or cinders. Paving brick cost about twice as much as cement.[b]

If no other means of ventilation than the windows are provided, they should be so arranged that entering air currents will be directed upward when the windows are opened and direct drafts on the hogs avoided. The size of the house and its equipment will depend upon the size of the herd and the resources of the owners. Not more than 50 breeding hogs should be confined in one house; sanitary considerations make a smaller number much safer. Out of doors the number of hogs in one inclosure may be increased considerably above 50 without danger.

Under any circumstances, the house should be well constructed and warm. If boarded up inside with good matched siding, such a house will be comfortable in zero weather and sows may farrow there with safety. Concrete or brick floors are expensive, but if the initial

[a] Thirteenth Biennial Report of Kansas State Board of Agriculture, p. 695.
[b] Breeder's Gazette, February 18, 1903.

expense can be incurred and the floors are well laid, they will pay good interest in the saving of manure and the dryness of the house. Animals should not be compelled to sleep directly on such floors, for rheumatism and colds are very likely to result. The best floor for a sleeping or farrowing pen is one of wood on concrete, the wood being 2-by-4 timbers, laid from one-fourth to three-eighths inch apart to allow drainage. If not constructed in this way, concrete and brick floors should be kept well littered. A clay or ordinary earth floor is excellent, and by some preferred to any other. It is the warmest floor, but not so easily kept clean as one of brick or concrete. If a house is constructed with earth floors, care must be taken that they are well drained, both underground and on the surface. The greatest necessity for a good house is at farrowing time, for it is then that more pigs die than at any other. If the sow farrows in a damp or cold place or in drafts, serious results to the sow or the pigs or to both will follow. At this time the sow is seriously weakened and she is very susceptible to exposure, while new-born pigs are easily stunted or killed by chilling. Rheumatic complaints are common with pigs and are often caused by damp, chilly sleeping places.

PORTABLE HOUSES.

The portable house is coming into very general favor, especially in disease-infested districts. They are of various forms and should be large enough for five or six grown hogs, with enough height to allow a man to stand erect; 6 by 6 feet or 8 by 8 feet are good sizes. Such houses should be strongly constructed of good lumber, with perfectly tight siding and roof. They are generally made without floors. If lined inside with the same materials as outside, such a house will be warm enough for a sow and pigs in zero weather.

A chief advantage of a portable house over the piggery system of several pens and a large number of hogs under one roof is its ease of management in times of epidemic. Only a few animals may be kept in one pen, and the isolation of the diseased animals when an outbreak begins is thus rendered comparatively easy. When cholera breaks out in a crowded piggery, every animal in the building is exposed, and the farmer, though he may isolate the unaffected animals at once, does not know how soon the second outbreak will occur; he has no check whatever on the epidemic. But with portable hog houses each house is itself a cholera check and only infection directly from diseased animals can spread the disease.

HOUSING IN MILD CLIMATES.

In the South and in much of the country west of the main chain of the Rocky Mountains the winters are sufficiently mild to obviate the necessity of constructing buildings of much warmth. Not only are

the winters mild, but they are comparatively short, and green feed is available much longer than in other parts of the country. In such localities a shed will often suffice, but it should be well constructed in order to provide protection from storms and damp, chilly weather. The location, as that of a piggery, should be high and well drained, affording clean, dry sleeping places; the shed should open to the south. The expense of such a building is well warranted in view of the added comfort to the stock and increased number of pigs raised. Under all circumstances, regardless of climate, whether a man is breeding purebred stock or grades, hogs should have sleeping places that are dry and warm and feeding places that are clean.

PENS AND PASTURES.

The question of pens and pastures, both as to size and location, must be determined by each one for himself. Local conditions, expense, and convenience must be considered. A good rule to follow is to favor large inclosures rather than small ones. A number of pens and several pastures will be found a convenience and are particularly valuable when disease makes its appearance, as hogs affected may then be removed at once. A quarantine pen with an absolutely tight fence should be arranged on every farm where hogs are kept. Here all new-purchased hogs should be confined after arriving at the farm until all danger of infection is past.

It will generally be a satisfactory practice to keep hogs away from other stock, except when following fattening steers. Pregnant brood sows should never be allowed to run in the same yards or pastures with cattle, horses, or mules. Many good sows have been ruined by the playfulness or viciousness of the larger farm animals.

The pen and yard for the boar should be separate from the rest of the herd and out of sight of it. The pen should be so strong that the boar can not tear it down or go through it, and a tightly fenced pasture of one-half to 1 acre in area should adjoin.

A "down"[a] pigging sow, if she is to farrow in the piggery, can have the run of the alley for exercise. If she has a house to herself, a small yard should adjoin.

FENCING.

No man should attempt to raise hogs without adequate fencing of yards and pastures. An animal of any kind, but especially a hog, can make himself an intolerable nuisance if not confined within proper bounds. For pastures woven wire is the best fencing material, all things considered. Such a fence may be purchased ready-made or may be made on the farm by machines. There are several good kinds on the market. From motives of economy, it may be desired to run a fence of woven wire around a field to a height of 30 to 36 inches, and above this to stretch two or three strands of ordinary

[a] A sow about to farrow.

barb wire. This will make a hog-tight fence, and if horses are necessarily placed in the field the fence will be much safer than the ordinary one made entirely of barb wire. Midway between the posts the lower strand in the fence should be securely stapled to a small post or stake; this will prevent hogs from working their way under the fence. In building any kind of wire fence ground wires may be put down to moisture at frequent intervals to give stock protection from lightning.

A board fence makes, perhaps, the most secure inclosure for hogs, but its expense precludes its use generally except for yards and pens. These should always be of boards, stoutly nailed to strong, well-set posts.

Barb wire is very poor material for a hog fence. It can hardly be made close enough or strong enough to prevent a shoat from crawling through. In this respect it is only a little better than a hedge, which is expensive and unsatisfactory when used to confine stock. Gates must, of course, be carefully made, hung, and fastened.

SELECTION OF BREEDING STOCK.

THE BREED.

The question of breed, though agitated to a less extent at present than during ordinary years, is, nevertheless, complicated and will continue to be so as long as man eats meat. Each breed has its merits, and family attachments, personal preferences, and the influence of environment will never fail to create strong and healthy partisanship for each breed of established reputation. However, in actual practice, the man who feeds for the market recognizes, not breed, but type. His selections may be made promiscuously from among the available material, but all are required to conform to a certain standard, which, when fattened, is the hog demanded by the market; for with all meat-producing animals the stock that is fed for market must conform to market requirements to return a profit to the feeder. Therefore if they are to maintain their standing the breeds that produce these animals must be managed so that their produce will meet the market demands, and thus the market qualifications become the standard, not only for a few breeds, but for all. This is particularly noticeable in the case of the breeds of beef cattle and hogs.

SIMILARITY OF TYPE IN DIFFERENT BREEDS.

Among breeds of hogs, therefore, differences between the breeds will be noticed principally in details. For example, the advocates of one breed want a hog with a deeply dished face, a short nose, and an erect ear. Such are the Berkshire breeders. Breeders of Poland Chinas do not breed for so great a dish in the face nor for so short a nose, and usually take an ear that is "broken" about one-fourth its

length from the tip. In their color requirements the breeders of both prefer black with six white points (feet, face, and brush of tail). Again, Duroc Jersey and Chester White breeding hogs show even closer similarity of individuals than Berkshires and Polands, but are readily distinguishable by the characteristic colors. But on the points that represent the real meat-yielding parts of the animals the standards are almost identical. Breeders look for quality, depth, length, and width of form and depth and condition of flesh, regardless of whether their hogs are black, red, or white.

At first sight breeds of the bacon type seem to be exceptions to this rule, but as yet there is not in the United States what can be called a general market class for hogs of this type. Packers explain this by saying that the scarcity of supplies of bacon hogs precludes their distinction as a separate market class. At present (1902) the hog that sells for the highest price on the markets of the central West is the hog of the lard type. Nevertheless, competent authorities are strongly of the opinion that the consumer's demand in the not far distant future will undergo a change and require a cut of pork that contains relatively more lean and less fat. If the public demand changes, the prices paid by packers will show a discrimination in favor of such an animal and the type will change. Such a transformation has taken place in the hog of England during the past twenty-five years; also in both England and America the highest type of steer demanded by the market has been changed from a huge fat 3-year-old, weighing up to 2,000 pounds, to the small handy-weight steer, weighing from 1,200 to 1,600 pounds. The possibility of a change in our hog type is apparent, but if it comes it will hardly result in supplanting any of the native breeds of this country. Their hold on the soil and the natural plasticity of conformation of the hog will cause American breeders to bring their standards to conform to market requirements. Prejudices will be cast aside, markets will be studied, rigid selection practiced. All animals that do not show the proper conformation will be eliminated from the breeding herd until the new conditions have been met. In any case the argument holds that the breed standards are molded by market qualifications and that the ideals of all breeds tend to converge into a common type.

How closely the breeds conform to a common standard may be seen by a perusal of the following comparative score card:

Comparative Score Card of Five Breeds of Hogs of the Lard Type.

[Compiled from the score cards of the National Association of Expert Judges on Swine.]

DETAILED DESCRIPTION.

HEAD.

Poland China.—Head broad, even, and smooth between and above the eyes; slightly dished, tapering evenly and gradually to near the end of the nose; inclined to shortness, but not enough to give the appearance of stubby nose; in male a masculine expression and appearance; broad lower jaw.

Berkshire.—Head short, broad, coming well forward at poll; face short and fine and well dished, broad between the eyes, tapering from eyes to point of nose, surface even and regular.

Duroc Jersey.—Head small in proportion to size of body, wide between eyes; face nicely dished (about half way between a Poland China and a Berkshire) and tapering well down to the nose, surface smooth and even.

Chester White.—Head short and wide; cheeks neat but not too full; jaws broad and strong; forehead medium, high, and wide; face short and smooth, wide between the eyes; nose neat and tapering and slightly dished.

Victoria.[a]—Head rather small and neat; face medium, dished, and smooth, wide between eyes, and tapering from eyes to nose.

Objections.

Poland China.—Head long and narrow between the eyes; nose uneven and coarse; too large at the muzzle or head too short; not full or high above the eyes or too much wrinkled around or above the eyes.

Berkshire.—Head long, narrow, and coarse; forehead low and narrow; jaws narrow or contracted; lower jaw extending beyond upper; face long and straight between eyes; nose coarse, thick, or crooked or ridgy.

Duroc Jersey.—Head large and coarse, narrow between the eyes; face straight; nose crooked or too much dished.

Chester White.—Head long, narrow, and coarse; forehead low and narrow; jaws contracted and weak; face long, narrow, and straight; nose coarse, clumsy, or dished like a Berkshire.

EYES.

Poland China.—Full, clear, prominent, and expressive.

Berkshire.—Very clear, rather large, dark hazel or gray.

Duroc Jersey.—Lively, bright, and prominent.

Chester White.—Large, bright, clear, and free from wrinkles of surrounding fat.

Victoria.—Medium size, prominent, bright, clear, and lively in young and of quiet expression in aged animals.

Objections.

Poland China.—Dull of expression, deep set, or obscure; sight impaired by wrinkles, fat, or other cause.

Berkshire.—Small, dull, bloodshot, deep set, or obscure; sight impaired by wrinkles, fat, or other causes.

Duroc Jersey.—Dull, weak, and obscure.

Chester White.—Small, deep, or obscure; sight impaired in any way.

EARS.

Poland China.—Ears attached to the head by a short, firm knuckle, giving free and easy action; standing up slightly from the base to within two-thirds of the tip, where a gentle break, or drop, should occur; in size neither too large nor too small, but even, fine, thin, leaf shape; slightly inclined outward.

Berkshire.—Generally almost erect, but sometimes inclined forward with advancing age; medium size, thin, and soft.

Duroc Jersey.—Medium, moderately thin, pointing forward, downward, and slightly outward, carrying a slight curve; attached to head very neatly.

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[a] The Victoria standard is that of the Victoria Swine Breeders' Association, but it has been adopted by the Association of Expert Judges for their use and is published along with their own score cards.

Chester White.—Medium size, not too thick, soft; attached to the head so as not to look clumsy; pointing forward and slightly outward; fully under control of the animal; drooping so as to give a graceful appearance.

Objections.

Poland China.—Large, floppy, straight, upright, or coarse; knuckle long, letting the ear drop too close to the head and face, hindering the animal in their free use.

Berkshire.—Large, coarse, thick, round, or drooping; long or large knuckle; difference in form or position from each other; animal unable to control their position.

Duroc Jersey.—Very large, nearly round, very thick, swinging, or flabby; not of same size; differing in position, and not under control of animal.

Chester White.—Large, upright, coarse, thick, round, too small, dropping too close to the face; animal unable to control them.

NECK.

Poland China.—Short, wide, even, smooth, well arched; rounding and full from poll to shoulder, with due regard to the characteristics of the sex.

Berkshire.—Full, deep, short, and slightly arched, broad on top, well connected with shoulder.

Duroc Jersey.—Short, thick, and very deep and slightly arching.

Chester White.—Wide, deep, short, and nicely arched.

Victoria.—Medium wide, deep, short, well arched, and full at top.

Objections.

Poland China.—Long, narrow, thin, and drooping from the shoulder to the poll, with unevenness caused by wrinkles or creases.

Berkshire.—Long, flat, lacking in fullness and depth.

Duroc Jersey.—Long, shallow, and thin.

Chester White.—Long, narrow, thin, flat on top, tucked up, not extending down to the breastbone.

JOWL.

Poland China.—Full, broad, deep, smooth, and firm, carrying fullness back near to point of shoulders, and below line of lower jaw, so that lower line will be as low as breastbone when head is carried up level.

Berkshire.—Full, firm, and neat, carrying fullness back to shoulder and brisket.

Duroc Jersey.—Broad, full, and neat, carrying fullness back to point of shoulders and on a line with breastbone.

Chester White.—Full, smooth, neat, and firm, carrying fullness back to shoulder and brisket when the head is carried up level.

Victoria.—Medium full, nicely rounded, neat, and free from loose, flabby fat.

Objections.

Poland China.—Light, flabby, thin, and wedge shaped; deeply wrinkled, not drooping below line of lower jaw, and not carrying fullness back to shoulder and brisket.

Berkshire.—Light, flabby, thin, tucked up or wrinkled.

Duroc Jersey.—Too large, loose, and flabby; small, thin, and wedging.

Chester White.—Light, too large and flabby, rough, and deeply wrinkled; not carrying fullness back to shoulder and brisket.

SHOULDERS.

Poland China.—Broad and oval at the top, showing evenness with the back and neck, with good width from the top to the bottom, and even smoothness, extending well forward.

Berkshire.—Broad, deep, and full; not extended above line of back, and as wide on top as back, carrying size down to line of belly, and having lateral width.

Duroc Jersey.—Moderately broad, very deep and full, carrying thickness well down and extending above line of back.

Chester White.—Broad, deep, and full, extending in a straight line with the side, and carrying size down to line of belly.

Victoria.—Broad, deep and full; not higher than the line of back and as wide on top as back.

Objections.

Poland China.—Narrow at the top or bottom, not so deep as the body, uneven width; shields on pigs under eight months of age, or showing too much shield at any age.

Berkshire.—Lacking in depth or width; thick beyond the line of sides and hams or extending above line of back; heavy shields on hogs under eighteen months of age.

Duroc Jersey.—Small, thin, shallow, extending above line of back; boars under one year old heavily shielded.

Chester White.—Narrow at top or bottom; not full nor same depth as body, extending above line of back; shields on boars too coarse and prominent.

CHEST.

Poland China.—Large, wide, deep, and full; even underline to the shoulder and sides, with no creases; giving plenty of room for heart and other organs, making a large girth, indicating much vitality. Brisket smooth, even, and broad; wide between the legs, and extending well forward, showing in front.

Berkshire.—Large, wide, deep, and roomy; full girth; breast bone curving well forward, extending back on level; not tucked up; broad between fore legs.

Duroc Jersey.—Large, very deep, filled full behind shoulders; breast bone extending well forward so as to be readily seen.

Chester White.—Large, deep, and roomy so as not to cramp vital organs; full in girth around the heart; the breast bone extending forward so as to show slightly in front of legs and let down so as to be even with line of belly, showing a width of not less than 7 inches between fore legs of a full-grown hog.

Victoria.—Large, wide, deep, and roomy, with large girth back of shoulders.

Objections.

Poland China.—Pinched appearance at the top or bottom, or tucked in back of the fore legs; showing too narrow between the legs; not depth enough back of the shoulder; brisket uneven, narrow, not prominent.

Berkshire.—Flat, narrow at top or bottom, small girth, lacking depth or fullness; breast bone crooked or tucked up.

Duroc Jersey.—Flat, shallow, or not extending well down between fore legs.

Chester White.—Narrow, pinched, heart girth less than flank girth, too far let down between fore legs, breast bone crooked or too short.

BACK AND LOIN.

Poland China.—Broad, straight, or slightly arched, carrying same width from shoulder to ham; surface even, smooth, free from lumps, creases, or projections; not too long but broad on top, indicating well-sprung ribs; should not be higher

at hip than at shoulder and should fill out at junction with side, so that a straight-edge placed along at top of side will touch all the way from point of shoulder to point of ham; should be shorter than lower belly line.

Berkshire.—Broad and straight, carrying same width from shoulder to ham; surface even and smooth without creases or projections, and not too long.

Duroc Jersey.—Back medium in breadth, straight or slightly arching, carrying even width from shoulder to ham; surface even and smooth.

Chester White.—Back broad on top, straight or slightly arched, uniform width, smooth, free from lumps or rolls, shorter than lower belly line, same height and width at shoulders as at ham; loin wide and full.

Victoria.—Broad, straight, or slightly arched, carrying same width from shoulders to ham, level and full at loin, sometimes higher at hip than at shoulder.

Objections.

Poland China.—Narrow, creased back of shoulders, swayed or hollow, dropping below a straight line; humped or wrinkled; too long or sunfish shape; loin high, narrow, depressed, or humped up; surface lumpy, creased, ridgy, or uneven; width at side not so great as shoulder and ham.

Berkshire.—Narrow, swayed, or hollow, dropping below a straight line.

Duroc Jersey.—Narrow, creased behind shoulders, swayed or humpbacked.

Chester White.—Back narrow, creased back of shoulders, sunfish shape, humped, swayed, too long or lumpy rolls, uneven in width; loin narrow, depressed, or humped.

SIDES AND RIBS.

Poland China.—Sides full, firm, and deep, free from wrinkles, carrying size down to belly; even from ham to shoulder; ribs of good length, well sprung at top and bottom.

Berkshire.—Sides full, smooth, firm, and deep, carrying size down to belly; even from ham to shoulder; ribs long, strong, well sprung at top and bottom.

Duroc Jersey.—Sides very deep, medium in length, level between shoulders and hams and carrying out full down to line of belly; ribs long, strong, and sprung in proportion to width of shoulders and hams.

Chester White.—Sides full, smooth, deep, carrying size down to belly, even with line of ham and shoulder; ribs long, well sprung at top or bottom, giving the hog a square form.

Victoria.—Ribs well sprung at top, strong, and firm; sides deep, full, smooth, and firm, free from creases.

Objections.

Poland China.—Flat, thin, flabby, pinched, not as full at bottom as at top; drawn in at shoulder so as to produce a crease, or pinched and tucked up and in as it approaches the ham; uneven surface; ribs flat or too short.

Berkshire.—Flat, thin, flabby, not so full at bottom as at top; ribs weak; not well sprung at top or bottom.

Duroc Jersey.—Flabby, creased, shallow, and not carrying proper width from top to bottom.

Chester White.—Flat, thin, flabby, compressed at bottom, shrunken at shoulder and ham; uneven surface; ribs flat and too short.

BELLY AND FLANK.

Poland China.—Belly broad, straight, and full, indicating capacity and room, being about the same or on a level at the flank with the underline of the chest. Underline straight, or nearly so, and free from flabby appearance.

Berkshire.—Wide, full, and straight on bottom line.

Duroc Jersey.—Straight and full and carrying well out to line of sides; flank well down to lower line of sides.

Chester White.—Same width as back, full, making a straight line, and dropping as low at flank as at bottom of chest; line of lower edge running parallel with sides; flank full and even with body.

Victoria.—Wide, straight, and full: as low or slightly lower at flank than at chest: flank full and nearly even with the sides.

Objections.

Poland China.—Belly uneven and flabby or apparent looseness in the make-up; pinched up in the flank or flanked too high.

Berkshire.—Belly narrow and sagging; flank thin and tucked up.

Duroc Jersey.—Narrow, tucked up or drawn in, sagging, or flabby.

Chester White.—Belly narrow, pinched, sagging, or flabby; flank thin, tucked up, or drawn in.

HAMS AND RUMP.

Poland China.—Hams broad, full, deep, and long from rump to hock. Fully developed above and below, being wide at the point of the hip, carrying width well down to the lower part of the hams; fleshy, plump, rounding fullness perceptible everywhere; rump rounding and gradually sloping from the loin to the root of the tail; broad and well developed all along from loin and gradually rounding to the buttock; lower front part of ham should be full, and stifle well covered with flesh; even width of ham and rump with the back, loin, and body; even a greater width as to females, not objectionable.

Berkshire.—Hams broad, full, and long; the lower front part of ham should be full and stifle well covered with flesh, coming well down on hock; rump should have a rounding slope from loin to root of tail, same width as back, and filling out on each side and above the tail.

Duroc Jersey.—Broad, full, and well let down to the hock; buttock full and coming nearly down and filling full between hocks; rump should have a round slope from loin to root of tail, same width as back, and well filled out around tail.

Chester White.—Ham broad, full, wide, long, and deep, admitting of no swells; buttock full, neat, and clean, thus avoiding flabbiness; stifle well covered with flesh, nicely tapering toward the hock; rump should have a slightly rounding shape from loin to root of tail, same width as back, making an even line with sides.

Victoria.—Hams long, full, wide, nicely rounded, trim, and free from fat; buttocks large and full, reaching well down toward hocks; rump slightly sloped from end of loin to root of tail.

Objections.

Poland China.—Ham short, narrow, too round, or too slim; not filled out above or below, or unshapely for deep meat; not so wide as the body; back or loin too tapering or small; rump narrow or pointed, not plump or well filled, or too steep from loin to the tail.

Berkshire. Ham narrow, short, thin, not projecting beyond and coming down on hock; cut up too high in crotch; rump flat, narrow, or too steep.

Duroc Jersey.—Ham narrow, short, thin, not projecting well down to hock; cut up too high in crotch; rump narrow, flat, or peaked at root of tail, or too steep.

Chester White.—Ham narrow, short, not filled out to stifle, too much cut up in crotch or twist, not coming down to hock; buttocks flabby, rump flat, narrow, too long, too steep, sharp or peaked at root of tail.

LEGS AND FEET.

Poland China.—Legs medium length, straight, set well apart and squarely under body, tapering, well muscled and wide above knee and hock; below hock and knee, round and tapering, capable of sustaining weight of animal in full flesh without breaking down; bone firm and of fine texture; pasterns short and nearly upright; feet firm, short, tough, and free from defects.

Berkshire.—Legs short, straight, and strong, set wide apart with hoofs erect and capable of holding good weight.

Duroc Jersey.—Medium size and length, straight, nicely tapered, wide apart, and well set under the body; pastern short and strong; feet short, firm, and tough.

Chester White.—Legs short, straight, set well apart and squarely under body; bone of good size; firm, well muscled, wide above knee and hock; below knee and hock round and tapering, enabling the animal to carry its weight with ease; pastern short and nearly upright; feet short, firm, tough, and free from defects.

Victoria.—Legs short, set well apart and firm, wide above knee and hock, tapering below; feet firm and standing well up on toes.

Objections.

Poland China.—Legs long, slim, coarse, crooked; muscles small above hock and knee; bone large, coarse, as large at foot as above knee; pasterns long, slim, crooked, or weak; the hocks turned in or out of straight line: legs too close together; hoofs long, slim, and weak; toes spreading or crooked or unable to bear up weight of animal without breaking down.

Berkshire.—Legs long, slim, coarse, crooked; muscles light, pastern long, slim, or flat; feet long or sprawling.

Duroc Jersey.—Legs extremely long or very short, slim, coarse, crooked; as large below knee and hock as above, set too close together; hocks turned in or out of straight line; feet, hoofs long, slim, and weak toes, spreading or crooked.

Chester White.—Legs too short, long, slim, crooked, too coarse, too close together; weak muscles above hock and knee; bone large and coarse, without taper; pastern long, crooked, slim, like a deer's; hoofs long, slim, weak; toes spreading, crooked, or turned up.

TAIL.

Poland China.—Tail of medium length and size, smooth, and tapering well and carried in a curl.

Berkshire.—Set well up, fine, tapering, and neatly curled.

Duroc Jersey.—Medium, large at base and nicely tapering and rather bushy at end.

Chester White.—Small, smooth, tapering, well set on, root slightly covered with flesh, carried in a curl.

Victoria.—Small, fine, and tapering, nicely curled.

Objections.

Poland China.—Coarse and long without a curl; or short, crooked, or stubby; or too small, fine, even, not tapering.

Berkshire.—Coarse and straight, too low.

Duroc Jersey.—Extremely heavy, too long, and ropy.

Chester White.—Coarse, long, clumsy, set too high or too low, hanging like a rope.

COAT.

Poland China.—Fine, straight, smooth, lying close to and covering the body well; not clipped; evenly distributed over the body.

Berkshire.—Fine, straight, smooth, lying close to and covering the body well; not clipped; evenly distributed over the body.

Duroc Jersey.—Moderately thick and fine, straight, smooth, and covering the body well.

Chester White.—Fine, straight, or wavy, evenly distributed, and covering the body well; nicely clipped coat no objection.

Victoria.—Fine and silky, evenly covering the body.

Objections.

Poland China.—Bristles, hair coarse, harsh, thin, wavy, or curly; swirls, standing up, ends of hair split and brown, not evenly distributed over all of the body except belly; clipped coat should be cut 1.5 points.

Berkshire.—Hair coarse, harsh, wavy or curly, not evenly distributed over body; swirls or clipped.

Duroc Jersey.—Too many bristles, hair coarse, harsh, and rough, wavy or curly; swirls or not evenly laid over the body.

Chester White.—Bristles, hair coarse, thin, standing up, not evenly distributed over the body, except the belly.

COLOR.

Poland China.—Black with six white points—tip of tail, four white feet, and white in face, on the nose or on the point of lower jaw—all to be perceptible without close examination; splashes of white on the jaw, legs, or flank, or a few spots of white on the body not objectionable.

Berkshire.—Black, with white on feet, face, tip of tail, and an occasional splash on arm.

Duroc Jersey.—Cherry red without other admixtures.

Chester White.—White (blue spots or black specks in skin shall not indicate impurity of blood).

Victoria.—White, with occasional dark spots on skin.

Objections.

Poland China.—Solid black, white mixed or sandy spots; speckled with white hairs over the body; mottled face of white and black; hair mixed, making a grizzly appearance.

Berkshire.—Solid black or black points, or white spots on body.

Duroc Jersey.—Very dark red or shading brown, very pale or light red, black spots over the body, black flecks on belly and legs not desired, but admissible.

Chester White.—Color any other than white.

SIZE.

Poland China.—Large for age; condition, vigor, and vitality to be considered. There should be a difference between breeding animals and those kept or fitted for the show of at least 25 per cent in size. In show condition, or when fat, a 2-year-old boar should not weigh less than 600 pounds, and a sow not less than 500 pounds; boar 1 year and over, 400 pounds; sow, 350 pounds; boar 18 months' old, 500 pounds; sow, 450 pounds; boars and sows 6 months' old, not less than 160 pounds; all hogs in just fair breeding condition, one-fourth less for size. The keeping and chance that a young hog has cuts quite a figure in his size and should be considered, other points being equal. Fine quality and size combined are the desirable points.

Berkshire.—Large for age; boar 2 years and over, not less than 450 pounds; sow, same age, 400 pounds; boar 18 months, 350 pounds; sow, same age, 325 pounds; boar 12 months, 300 pounds; sow, same age, 275 pounds; boar and sow 6 months, 150 pounds.

Duroc Jersey.—Large for age and condition; boars 2 years old and over should weigh 600 pounds; sow, same age and condition, 500 pounds; boars 18 months, 475 pounds; sow, 400 pounds; boars 12 months, 350 pounds; sow, 300 pounds; boar and sow pigs 6 months, 150 pounds. These figures are for animals in a fair show condition.

Chester White.—Large for age and condition; boars 2 years old and over, if in good flesh, should weigh not less than 500 pounds; sow, same age and condition, not less than 450 pounds; boars 18 months old, in good flesh, should weigh not less than 400 pounds; sows, 350 pounds; boars 12 months old, not less than 300 pounds; sows, 300 pounds; boars and sows 6 months old, not less than 150 pounds each; and other ages in proportion.

Victoria.—Boars 2 years old and over, when in good condition, should weigh not less than 500 pounds; sow, same age and condition, 450 pounds; boar 12 months old, not less than 300 pounds; sows in good flesh, 300 pounds; pigs 5 to 6 months old, 140 to 160 pounds.

Objections.

Poland China.—Overgrown, coarse, flabby, loose appearance; gangling, hard to fatten; too fine; undersize; short, stubby, inclined to chubby fatness; not a hardy, robust animal.

Berkshire.—Underweight, coarse, not in good form to fatten.

Duroc Jersey.—Rough and coarse and lacking in feeding qualities.

Chester White.—Overgrown, coarse, uncouth, hard to fatten.

ACTION AND STYLE.

Poland China.—Action vigorous, easy, and graceful; style attractive; high carriage; in males testicles should be prominent and of about the same size, yet not too large and pouchy.

Berkshire.—Action vigorous; style graceful and attractive.

Duroc Jersey.—Action vigorous and animated; style free and easy.

Chester White.—Action easy and graceful; style attractive; high carriage; in males testicles should be readily seen, same size and carriage.

Victoria.—Action easy and graceful, but quiet.

Objections.

Poland China.—Clumsy, slow, awkward movement; low carriage; waddling or twisting walk; a seemingly tired or lazy appearance; not standing erect and firm.

Berkshire.—Dull, sluggish, and clumsy.

Duroc Jersey.—Dull or stupid, awkward, and wabbling; in boars testicles not easily seen, nor of same size or carriage, too large, or only one showing.

Chester White.—Sluggish, awkward, low carriage, wabbling walk; in males testicles not easily seen, not of same size or carriage, or only one showing.

CONDITION.

Poland China.—Healthy, skin clear of scurf, scales, or sores; soft and mellow to the touch; flesh fine, evenly laid on and free from lumps and wrinkles; hair soft and lying close to body; good feeding qualities.

Berkshire.—Healthy, skin clear of scurf, scales, or sores; soft and mellow to the touch; flesh fine, evenly laid on and free from lumps; hair soft and lying close to body; good feeding qualities.

Duroc Jersey.—Healthy, skin free from any scurf, scales, sores, or mange; flesh evenly laid over the entire body and free from any lumps.

Chester White.—Healthy, skin clear and bright, free from scurf or sores; flesh fine and mellow to the touch, evenly laid on and free from lumps; good feeding qualities.

Victoria.—Healthy, skin clear and white or pink in color; free from scurf; flesh firm and easily laid on.

Objections.

Poland China.—Unhealthy, skin scaly, wrinkled, scabby, or harsh; flabbiness or lumpy flesh; too much fat for breeding; hair harsh, dry, and standing up from body; poor feeders; deafness, partial or total.

Berkshire.—Unhealthy, skin scaly, scabby, or harsh; flabbiness or lumpy flesh; too much fat for breeding; hair harsh, dry, and standing up from body; poor feeders; deafness, partial or total.

Duroc Jersey.—Unhealthy, scurfy, scaly, sores, mange; too fat for breeding purposes; hair harsh and standing up; poor feeders.

Chester White.—Unhealthy, skin scaly, scabby, or harsh; flesh lumpy or flabby; hair harsh, dry, and standing up from body; poor feeders; total deafness.

DISPOSITION.

Poland China.—Lively, easily handled, and seemingly kind and responsive to good treatment.

Berkshire.—Quiet, gentle, and easy to handle.

Duroc Jersey.—Very quiet and gentle; easily handled or driven.

Chester White.—Quiet, gentle, and easily handled, with ambition enough to look out for themselves if neglected.

Victoria.—Quiet and gentle.

Objections.

Poland China.—Cross, sluggish, restless, wild, or of a vicious turn.

Berkshire.—Cross, restless, vicious, and wild.

Duroc Jersey.—Wild, vicious, or stubborn.

Chester White.—Cross, restless, vicious, or wild; no ambition.

DISQUALIFICATIONS.

FORM.

Berkshire.—Very large and heavy or drooping ears; small, cramped chest-crease back of shoulders and over the back so as to cause a depression in back easily noticed; deformed or crooked legs; feet broken down, so that the animal walks on pastern joints.

Duroc Jersey.—Ears standing erect; small, cramped chest; crease back of shoulders and over back, so as to cause a depression in the back easily noticed; seriously deformed legs; badly broken-down feet.

Chester White.—Upright ears; small, cramped chest; crease around back of shoulders and over the back, causing depression easily noticed; feet broken down, causing the animal to walk on joints; deformed or badly crooked legs.

Victoria.—Crooked jaws or deformed face; crooked or deformed legs; large, coarse, drooping ears.

SIZE.

Berkshire.—Overgrown, gangling, narrow, contracted, or not two-thirds large enough for age.

Duroc Jersey.—Very small or not two-thirds large enough, as given by the standard.

Chester White.—Chuffy, or not two-thirds large enough for age.

CONDITION.

Berkshire.—Barrenness, deformed, seriously diseased, total blindness from any cause.

Chester White.—Squabby fat, deformed, seriously diseased, barrenness, total blindness.

Victoria.—Excessive fatness, barrenness, deformity in any part of the body.

SCORE.

Berkshire.—Less than 60 points.

Duroc Jersey.—Less than 50 points.

Chester White.—Less than 60 points.

PEDIGREE.

Berkshire.—Not eligible to record.

Duroc Jersey.—Not eligible to record.

Chester White.—Not eligible to record.

Victoria.—Not eligible to record.

COLOR.

Chester White.—Black or sandy spots in hair.

Victoria.—Other than white or creamy white, with occasional dark spots in skin.

Differences between breeds as units.—The foregoing remarks apply to the individual characteristics of the animals of the different breeds, regarding them simply from the meat-producing standpoint. Considering each breed as a unit, it will be noticed that there are varying degrees of adaptability to environment. One breed succeeds well in a certain locality while another does not; some breeds graze and "rustle" better than others. In the Northern States color is only an incidental item except in the case of purebred stock, where a color standard is always maintained; but in the Southern States white hogs are not desired, it being claimed that they are too susceptible to the heat of the sun.

SELECTION OF A BREED.

The principal point to be observed in the selection of a breed is, therefore, its adaptability to the climate and environment of the locality in which the beginner desires to operate. The best plan will be, obviously, to make a selection from the breeds already established in the neighborhood, consulting successful breeders freely. If, as sometimes happens, a man finds himself compelled by circumstances to become a pioneer in hog raising, a selection should be made from breeds already successful in sections of the country similar to his own. Broadly speaking, there is no "best breed." All have their strong points. Most of them will flourish in almost every part of the country; but consulting his own personal preferences and the locality in which he lives the farmer will find that, for his own use, there is probably a

breed that he may consider the best. When a breed is once chosen it should be reasonably adhered to, and promiscuous crossing with other breeds avoided.

THE BREEDER.

After the locality and breed have been decided upon, and the various details that are incident to a beginning settled, it may be well for the beginner to examine into his own qualifications. To make stock raising of any kind a success a man must be, first of all, a lover of animals, taking a delight in their growth and development and quick to understand their needs. He must enjoy the labor of caring for them and must be willing to give that labor without grudging and often without stint. He should be cleanly and neat in habits, and then his barnyard will be likewise. A knowledge of some of the laws of sanitation and veterinary science will be a great help, and an acquaintance with the principles of selection and breeding of stock is, of course, a necessity. The apparent ease with which many men succeed with live stock is due, in large measure, to the possession of this intimate knowledge of the habits and requirements of their animals. They do not pamper their stock, but they never neglect it. The personality of the breeder, including good health, natural intelligence, etc., has more to do with success or failure than any other factor after a suitable location, and will do wonders toward overcoming a harsh climate and an unproductive soil.

THE FOUNDATION HERD.

The first selection of breeding stock is of prime importance. The effects of mismating are always difficult to breed out of a herd, and the effect on a beginner is such that a mistake may completely discourage him. It is good economy to make haste slowly at this time. The start should be made with a few animals; five sows will make a large enough herd for the first year. They should be good individuals, and it will even be much better to buy one high-class sow than five poor ones. This will be real economy and the development of the herd will prove its value. It will be well if a beginner can obtain the assistance of an old and successful breeder in making a start.

SELECTING THE SOWS.

The expression "the male is half the herd" is repeatedly quoted. So far as our knowledge of heredity has developed, other conditions being equal, there is uniform prepotency in both sexes; the influence of the two parents on the offspring is theoretically equal. Therefore, if the boar is half the herd, the sows certainly make up the other half, and their selection is a highly important matter. They may be purchased, already bred, some time before the boar, and quite an item of expense will thus be saved. Then by the time the sows have been

watched and studied for a season and have each raised a litter of pigs, the owner will be much better prepared to select a suitable male, and he can then get one to use on both dams and offspring.

The sows selected should be nearly the same age, which should be about twelve months, and all should be safe in pig, preferably to the same boar. Their individual characteristics should, perhaps, be first looked to. While hogs do not show the strong differences of sex that we look for in a cow or a mare, these always constitute a marked feature of a good brood sow. The smoother forehead and lighter, finer neck are points of distinction from the signs of masculinity in a boar. The forehead should be broad between the eyes, the throat clean and trim, the neck moderately thin, and the shoulders smooth and deep; the back should be fairly wide and straight, and ample room for the vital organs should be provided by a good width and depth of chest, well-sprung ribs, and straight, deep sides—a deep, capacious body from end to end. Depth of chest and abdomen are specially important in a brood sow. Pinched chests and waists must be avoided. It is generally advised that sows with much length of body should be selected for breeding purposes, length of body being regarded as an indication of fecundity. It will certainly do no harm to select sows that are especially long, but care should be taken that quality go with the increase in length. The loose-jointed, long-coupled, slow-maturing, and slow-fattening type should not be allowed to get a foothold in the herd. The influence of length of body on a sow's fecundity is by no means positively known. Many very short-bodied sows have proved to be wonderfully prolific breeders. The surest means by which to select prolific sows is to keep an accurate record of the herd and cull all sows that do not yield a certain percentage annually. Each sow should have at least twelve well-developed teats, thus providing for the proper nourishment of large litters.

The important qualifications of the market hog should be looked for; viz, smoothly covered shoulders, a wide, straight, deeply fleshed back, well-sprung ribs, straight, deep sides, broad rumps, and deep, well-rounded hams. A broad, well-developed pelvic cavity will generally insure a sow easy in parturition. The body should stand on moderately short, straight legs, with a moderate amount of bone. All hogs, particularly breeding animals, should stand well up on the toes. There is a tendency, more marked in some breeds than in others, for the pasterns to break down, so that the animal walks on the pastern bone instead of on the toes. This is particularly the case of the hind pasterns and is oftener noticed in boars than in sows. It is a weakness that seriously impairs the usefulness of the animal.

Brood sows should, of course, show quality, but this should not become overrefined and delicate. Extremes of refinement usually lead to delicacy of constitution and often accompany sterility.

As a last but very important point, these first sows should be uniform in type. Uniformity of type goes far beneath the surface. It includes every part of the internal organization. The reproductive system, the digestive system, the circulatory system, and even the nervous system influence uniformity. The breeder may often be disappointed in his results from sows that he thought were of a uniform type. His pigs are a heterogeneous lot, unpleasing to the eye, unsatisfactory in the feed lot, and profitless to the pocket. In such a case a lack of uniformity in the powers of heredity may no doubt be assigned as the cause of these unfortunate results. It must be borne in mind that it is comparatively easy to select sows that are uniform in quality, constitution, and conformation. This may be done by any skillful judge of hogs. But our only basis for the selection of animals uniform in reproductive powers and heredity of type is the breeding record of their sires and dams and the standard of the herds from which they come. For this reason it is readily apparent why it is an advantage for the beginner to select his sows from one well-established herd. Whether the sows will be uniform in breeding powers can only be determined definitely by testing them in the herd, but to select them from the same herd or from herds of similar breeding will be a reasonable guaranty of good results. When a sow has shown herself to be a prolific breeder she should be retained as long as her reproductive powers are maintained.

Uniformity in a herd is the surest index to the worth of the stock and the skill of the breeder, and its advantages are obvious. A uniform lot of pigs will feed better, look better when fattened, and command a higher price on the market than a mixed lot. With a bunch of sows closely conforming to the same standard, whose reproductive powers are similar, uniform pigs may be expected.

The importance of the male in the herd should not be asserted at the expense of the females, yet the importance of a male of marked excellence must not be minimized. The boar represents 50 per cent of the reproductive power concentrated in one animal; the sows represent an equal amount of reproductive force, divided up among ten or twenty or fifty individuals. If, then, these females do not, in their conformation and fecundity, conform strictly to the same type, they are merely convenient machines for the birth and rearing of young—not what they might be, an influential force in furthering the plans of the breeder and raising the standard of the herd. It is not proposed to discuss at length in these pages the operation of the forces of prepotency as varying factors in breeding operations. The relative influence of one parent over another, the swamping of a weakly organized female influence by a strongly prepotent male factor, or vice versa, are interesting and important, but belong to the special study of heredity.

SELECTING THE BOAR.

If there is a tendency at times to exalt unduly the influence of the boar and neglect that of the sows, the beginner should not permit himself to reverse things and entirely neglect the boar. It was, indeed, the feeling that any male could be used so long as he had sufficient strength for service that brought about arguments in favor of the value of the boar. A breeder can not afford to neglect the animals of either sex. The male has, perhaps, the greater influence on the herd, for the simple reason that every pig in the herd is sired by him, whereas they have not all the same dam. To achieve the best results, a breeder should never allow the standard of his sows to be lowered, and should always couple them with a boar of a little better grade. One thing must not be forgotten, and it indicates the chief difference between the influence of the two sexes in the herd. A superior boar may be used on a herd of inferior sows with good results, but the use of an inferior boar on sows of high quality will have a disastrous outcome. The one method raises the standard of the herd; the other inevitably lowers it.

A boar with the male characteristics strongly developed should be selected, preferably as a yearling or else as a pig that had been purchased at the same time as the sows and allowed to come to maturity before using. He should have a strongly masculine head and a well-crested neck. His shoulders should be developed according to age; but strong shoulder development in pigs under a year or eighteen months is objectionable. The same indications of a good pork-producing carcass that the sows required should be seen in the boar—a broad, straight, deeply fleshed back, much depth and length of side, and well-developed hind quarters. The boar should be selected to correct any defects that may be common to the sows; for example, if the sows are rather coarse in bone and loosely built, the boar should have high quality—fine bone, skin, and hair. If the sows tend toward overrefinement and delicacy, the boar should be rather rangey and strong-boned. There is a common belief that the male parent influences principally the extremities and general appearance of the offspring, while the vital organs (the heart, lungs, and viscera) resemble those of the female parent. This theory is strongly questioned by some modern authorities on heredity; but so long as our knowledge of the subject is so limited and this particular phase is in dispute, it can do no harm to select breeding animals according to the old ideas. The visible organs of the reproductive system should be well developed and clearly defined. A boar should not be bought with small, indefinitely placed testicles. Avoid particularly a boar with only one testicle visible.

The boar should stand up on his toes. There should not be the slightest indication of weakness in the pasterns of a young one; in a

mature boar (2 or 3 years of age) that has seen hard service it may be expected that he will be a little down on his pasterns, but a 6 or 8 months old pig that does not carry himself on upright pasterns is not a safe animal to select for a herd boar; the hind pastern will be in much danger of breaking down with a little age and service. Look carefully to the set of the hind legs. The back should be carefully set, straight, and closely coupled to hindquarters. A crooked or long-coupled back is as great a drawback as a weak pastern.

FEED AND MANAGEMENT.

The details of selection, feed, and management of live stock are intricately interwoven and interdependent. A man may be an excellent judge of stock, able to select those animals for his herd whose use will give the best results in breeding; but if his system of feeding and management is not such that the animals will thrive and yield a good increase, good selecting is rendered ineffective. On the other hand, the herd may be carefully fed and skillfully managed, the feed may be the best and properly combined, the shelter warm and dry, and the water supply pure; but if the herd is poorly selected the owner is practically throwing away the feed he gives them.

THE SOWS.

Hogs require attention, regardless of condition, age, or sex, but the management of the brood sows is the surest test of the breeder's skill. If sows are carelessly fed during pregnancy, trouble of some kind is sure to ensue at farrowing; if overfed after farrowing, losses may occur among the pigs from scours and thumps. At no time is the development of the pigs so easily influenced as while they are dependent on the sow's milk—the first month of life. Excepting the ravages of epidemics, perhaps the greatest death losses in the herd occur during this time, including farrowing. The accidents during farrowing, an attack of scours due to the milk of the dam, or a chill while following the sow in pasture on a wet day, may stop growth temporarily, leaving a permanently stunted pig, or may result fatally. On the other hand, the results of good management during pregnancy are as marked as the unfortunate consequences of careless methods.

MANAGEMENT DURING PREGNANCY.

It is assumed that bred sows are purchased as the foundation stock. If these sows are not all from the same herd, they should not be placed together until they are all known to be free from vermin and contagious disease. They must be washed or dipped and quarantined from each other at least thirty days. If they come from the same herd, quarantine may not be necessary.

It is always well for a purchaser to ascertain from the seller the details of management and feeding to which the animals were accustomed before changing owners. This system of feeding should be conformed to; or, if this is not possible, the old ration should be gradually replaced by the more convenient one, the time of transition being from ten days to two weeks. For the first few days newcomers should be fed lightly.

During pregnancy two facts must be borne in mind. The first is that the sow is doing double duty. Not only is she keeping up her own bodily functions, but the development of the fetal litter is a constantly increasing drain on her system. Although feeding at this time will not need to be so heavy as after the pigs are farrowed, it should be liberal. The sow's condition should be "good"—neither too fat nor too lean. An error which would allow the sow to become fat would perhaps be least productive of serious consequences. It is hardly too much to say that the mistakes in feeding breeding animals are more frequently those that keep such stock in a thin, half-starved condition, under the idea that the reproductive organs are so peculiarly liable to become transformed into masses of fat that the least appearance of fat on the animal's back and ribs will be the first step in bringing about such unfortunate circumstances. The use of the reproductive organs in either sex creates demands of an unusual nature on the animal organism, and these demands must be met in the same manner as those of a different character—such as growth, work, etc.; and that is by providing liberal supplies of the proper kinds of feed. It is beyond reason that a sow can give birth to a strong litter of pigs after having gone through a four months' fast. The importance of ample feeding of pregnant females, in the case of sheep, has been shown recently by Mumford[a] in Missouri. He found that during the first six to nine weeks of life those lambs having the heaviest birth weight made the greatest gains; the records of the gains of the lambs after weaning were not tabulated. As the development of the fetus is intimately associated with the nutrition of the dam, it is urged that "we can profitably pay more attention to the development of the unborn lamb." Whether a similar fact may be true in the case of hogs is yet to be shown. It may not be unwise to assume that it may be so. Bad results undoubtedly may be brought about by overfeeding, especially as sows are naturally indolent and loath to exercise; but a counteracting influence will be found in ample exercise that may be provided by a large pasture, or even by driving slowly a mile or two each day. The necessity of exercise must not under any circumstances be overlooked.

It must be remembered, in the second place, that the main demands upon the sow are those for the building of new tissue. Hence the

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[a] Bul. No. 53, Missouri Expt. Sta.

kind of feed is important. What are known as the nitrogenous, or protein-bearing, feeds are needed at this time. These are bran, oil meal, pease, beans, oats, and barley, and, to a moderate extent, wheat. The forage plants that are especially suitable to pregnant brood sows are the clovers and their relatives—alfalfa, peas, beans, vetches, etc. The ordinary pasture grasses are also of much value. Feed should be given in such form that the system of the sow will be at its best. All breeders lay special emphasis on the condition of the bowels during pregnancy, and particularly at farrowing, the special danger to be avoided being constipation. To this end, the greater part, if not all, of the grain ration is given as slop; and, toward the close of the period of gestation, oil meal, or a small amount of flaxseed meal, is introduced into the ration.

Corn should not be fed in large amounts to breeding stock. If possible, it should not be fed at all to any but fattening animals. In the corn belt many farmers are often so situated that they have no other grain feed at hand. If corn must make up the greater part of the ration of the brood sow, the injurious effects may be counteracted in a measure by compelling the sows to exercise. Various schemes may be necessary to bring about this result, such as having the house and feeding floor or the feeding floor and watering place at opposite ends of the hog lot; so that a good walk is a necessity several times each day. If the lot is located on a hillside, the walk is made a climb. Some men scatter grain among straw and corn fodder with this idea of exercise in mind, and others resort to the whip and drive the sows gently for a mile or two each day.

During the winter more care will be needed to keep the sow in good health on account of the absence of pasture. Not only does the hog's system crave green feed, but more or less bulk is demanded. This is especially needed when a considerable amount of confinement is necessary. To offset the lack of green feed, nothing surpasses roots. These may be sliced or pulped and mixed with the grain or may be given whole, as a noon feed. Some care must be used in feeding roots, as they are laxative in effect, and if fed in excessive amounts, may bring about profuse action of the bowels. Some Eastern farmers recommend the use of silage. If neither is available, clover or alfalfa hay, sheaf oats, or corn fodder may supply the bulky requirement of the ration with good results. Charcoal, ashes, and salt should be accessible at all times. These act as a vermifuge and preventive of disease and meet the hog's craving for mineral matter in the feed. The constant use of such a preparation with a varied ration, will, in large measure, prevent sows from eating their pigs at farrowing time. During the entire period care should be taken to keep the system well toned. The condition of the bowels is highly important; for pregnant and "down" pigging sows are subject to constipation, which may have serious results during farrowing. The sow should become

accustomed to being handled, and should look upon her attendant as a friend.

All the brood sows may run together up to within two weeks of farrowing time; then it is well to separate them, placing each sow by herself in a yard with a small house, such as has been described, which should be dry, airy, and clean. A great deal of exercise will not now be necessary. The feed should be reduced somewhat, and, if there is any tendency to constipation, a slight change of feed may be necessary. If individual houses are not available sows can not be separated until near farrowing time.

The farrowing pen should be provided with fenders around at least three sides about 6 or 8 inches from the floor and 6 or 8 inches from the wall. These should be strong enough to support the weight of the sow should she lie on them. They will, in a large measure, protect the pigs from being lain upon during the first few days of their lives. This will go far to prevent a very fruitful cause of loss among young pigs. The little fellows will soon learn to creep under these fenders when the sow lies down.

Many breeders now use a specially arranged farrowing pen for sows, the object being to allow the sow room enough to farrow with reasonable comfort, but not enough to turn around. The safety of the pigs under such circumstances is said to be much greater than when the sow is given all the space she cares to take. Provision is made for the safety of the pigs by raising the walls of the pen 6 or 8 inches from the floor. Such a pen may be readily arranged by placing the sow at one end of her pen and nailing boards across so that she can not turn, leaving space for the pigs to slip under the barrier. A number of patented farrowing pens are on the market.

OPINIONS OF BREEDERS.

In the preparation of this bulletin, requests for methods and experience in hog raising were sent to successful breeders in different parts of the country. These men were practically all breeders of purebred hogs, and it may be objected at first thought that methods used by them are too expensive to warrant their application to the production of hogs for the market. To a certain extent this is true. A man with 50 or 100 sows will hardly find it possible or economical to keep an exact breeding record of each one; he can, however, keep himself acquainted with the breeding record of the herd by grouping those sows that are due to farrow at or near the same time and those that farrow or raise litters of certain numbers. Constitution, uniformity, disposition, etc., can all be regulated in a market herd in the same manner. In feed and management, however, the methods of the successful breeder of purebred animals may be taken as models. Because a pig is a grade is no reason why he should be compelled to live in filth, eat poor feed, and sleep where fortune compels him, often

without a semblance of shelter. There is, of course, a possibility that attention may be so assiduous that the animals suffer; but, where one hog is killed by care and kindness, thousands die from disease which gets its foothold on account of insanitary surroundings and improper feed. With this idea in view, the opinions of breeders on various phases of the industry are given. These opinions are the personal experiences of men in the business and represent various ideas and theories. It is therefore obvious that the Bureau of Animal Industry is not responsible for any statements made therein.

The following replies were among those given in response to the question, "What system of feed and management do you pursue to prepare sows for farrowing?"

George Aitken, Woodstock, Vt.—In the summer they are put into a separate inclosure with a temporary shelter; in the winter they are in separate pens and fed laxative feed—principally mangels.

H. O. Mathews, Concord, N. H.—I keep my brood sows in a moderate condition—not too fat; feed on hotel waste combined with mixed feed, sugar beets, and clover hay; give them exercise in yards all winter, and warm, dry beds, making sure that they have pure air.

E. W. Davis, Torringford, Conn.—The one thing needful is to have the bowels loose. I have had excellent success in feeding mangolds through the winter. These, with wheat bran, will bring the best of hogs. Sows should also have exercise; then, with the above feed, there is no danger of them destroying their pigs.

Theron E. Platt, Newtown, Conn.—For feed we use skim milk and wheat feed, with some green feed, such as roots and cabbage for winter and in summer grass or clover.

Richard H. Stone, Trumansburg, N. Y.—The sows are well cared for and well fed; feed warm bean soup with wheat bran or middlings, with some bone meal and tankage. To 150 head we feed about 400 gallons of soup per day.

Edward van Alstyne, Kinderhook, N. Y.—I keep my sows in good condition, not fat nor very thin, giving them laxative feed, and pasture if possible. In the winter they have silage or roots with wheat bran and plenty of exercise in the open air, on the ground if possible.

F. H. Gates & Sons, Chittenango, N. Y.—We feed middlings mixed with hominy meal or clear middlings in whey or skim milk; this will keep their bowels loose and the animals in good growing condition (not fat). We give a dry bed of straw, just a thin layer on the floor, and arranged so that the little pigs can not get into the gutter.

George L. Gillingham, Moorestown, N. J.—They are allowed the free run of the pasture the entire year, with warm, dry houses to sleep in, not over three or four being put together, to avoid crowding. The feed in summer is wheat middlings, apples, or other refuse fruit, and pasture; in the winter they have rye to graze when the snow is off, with roots, clover hay, middlings, etc., but very little corn.

William M. Dickson, Woodside, Del.—We give as large a lot to range as possible. The feed in winter is silage, turnips, and slop with bran and meal in it. This is varied with a little corn on the ear; never cob meal.

J. S. Burns, Clinton, Pa.—By breeding time in the fall the sows are usually rather thin in flesh, especially if they have raised a fall litter. For two or three

weeks before we mate them we feed some corn in connection with clover pasture; but if there is no pasture we use corn, milk, and mill feed, making a ration with a ratio of about 1:7 or 1:8, depending on the sow's condition. If she is in good flesh we do not begin so soon and the ration is made narrower. The object is to have the sow vigorous at breeding time. We continue the feeding in this way until they are in such flesh as most people would think fat enough for pork, then narrow the ration to about 1:4 or 1:5, dropping out the corn about four weeks before farrowing; if in midwinter, furnishing warm quarters instead of heat-producing feed, avoiding everything that would produce a feverish system. We feed turnips, beets, parsnips, etc., for succulence. We always allow exercise, giving the range of a pasture lot. The feeding place is some distance from the sleeping quarters.

N. S. Burrier, New Midway, Md.—After a sow weans her pigs I breed her at once, as she is generally thin in flesh. I feed her all she will eat of such feeds as bran and middlings, pasture, etc., and any feed, except corn. Feed only two ears of corn twice a day to each sow, but try to put on flesh with other feeds, giving the sow plenty of range. An apple orchard is a splendid place for this; if a spring branch runs through it, so much the better. By this method of feeding the sow is in good flesh by farrowing time and the pigs are large and strong; whereas, if the sow is shut up in a close pen and fed on corn, the pigs will be small and weak. Some people always say that my sows are too fat at farrowing time; but I find that theirs are too poor; one can hardly ever get a sow too fat on the right kind of feed and plenty of range.

John F. Lewis, Lynnwood, Va.—I generally feed shorts and bran made into a mash once a day and a feed of corn once, if the weather is very cold; if not, I feed shorts, bran, and barley, equally divided as to bulk.

Thomas S. White, Lexington, Va.—I have eight farrowing pens of two rooms each. I watch my gestation table and put the sows (one in each two-room house) a few days before farrowing, each sow then having a sleeping room and dining room; the former can be made perfectly close, the latter is open overhead. I feed bran mashes with a little corn for a week before farrowing.

J. C. Graves, Barboursville, Va.—I allow the pregnant sow plenty of range for exercise and feed mainly on bran, mill feed, and oats in winter, with some corn. In grazing time corn is all that is needed to supplement pasture.

Charles A. Kuhlmann, Hamilton, Va.—When nearing farrowing time I still allow my sows a grass range, if possible, or a lot in which to exercise themselves. Only a few are allowed to run together. I also furnish them with a good dry house, into which they can go at their own free will. I slacken the feeding until no corn at all is fed, and feed a mixture by weight of bran 3 parts, shorts or middlings 3 parts, corn meal 3 parts, old-process linseed meal 1 part, all in the form of slop.

W. K. Pickens, Livingston, Ala.—I feed wheat shorts made into slop and give the sow plenty of exercise, pure water, a warm sleeping place, and keep her free from all excitement.

W. E. Davis & Bro., Sherman, Tex.—When the sow is bred we put her on a pasture of some sort—oats, wheat, or alfalfa, as the case may be—and feed her on dry corn at night and soaked corn in the morning. We try to keep her gaining flesh all the time from breeding time to farrowing.

H. E. Singleton, McKinney, Tex.—From the weaning of one litter to the next farrowing sows have the run of a pasture and are fed bran and corn, the amount to be determined by the quality of the pasture.

Clifton Chisholm, Roswell, N. Mex.—My sows during the summer, when there is no green alfalfa, get nothing but alfalfa hay fed in racks for four months before farrowing. Out of 500 sows which farrowed this summer I had to assist only one.[a]

Mark Butlerton, Miller, Okla.—My system of managing the sows before farrowing is to give them plenty of range on green pasture, with plenty of oats and a little corn. This year (1902) I have fed ground wheat with the best of results. In all cases I am careful not to let the sows get too fat.

A. D. Outher, Homestead, Okla.—My sows are given lots of range and an abundance of green wheat, alfalfa, cowpeas, and rape, besides oats, barley, wheat, corn, and shorts. They have exercise, sunlight, and roomy pens.

H. P. Wilson, Gadsden, Tenn.—For spring farrow I usually breed in November or December and give the sows the run of the fields and woods, with winter oats, rye, and rape for green pasturage, until growth stops from the cold, then I give bran and middlings mixed into a fairly thin slop twice a day with a little shelled corn, giving the corn after the slop. In midwinter I give the sows such hay as I have—clover, millet, cut corn, pea vine, or sorghum. I usually warm water for them in very cold weather. They have comfortable small houses to sleep in, two or three sows being in each house until near the farrowing period, when I give each sow a separate house. I feed all the salt and ashes they want and occasionally give them a round of prepared stock food. Keep lice from them by coal oil and grease or some of the disinfectant dips, which are also used freely in and around the sleeping quarters.

Karl B. Clough, North Amherst, Ohio.—During the warm months the sow has a large range on clover and blue grass with plenty of good water and shade. Should this not give enough food to keep her putting on flesh, a thin slop of middlings twice a day is added. As she becomes heavier with pig the middlings are increased, with the end in view that the sow will be in good condition at time of farrowing. In the cold months she is fed cowpeas, soja beans, or clover hay that has been baled. To this is added a slop of middlings or barley and a little corn meal. During early spring winter rye is pastured and takes the place of hay. We aim to keep the sow increasing in weight from the time of service until she farrows. Wood ashes, salt, and sulphur should be before them at all times. A little bone meal in the slop is very good.

Aaron Jones, jr., South Bend, Ind.—We give our sows as much outdoor exercise as possible; in fact, we never aim to have hogs in inclosed pens at any time. We think hogs grow faster and are more healthy if kept on pasture, and never on the same pasture and feed lots to exceed two years. Sows get little corn; good rich slop made from bran, middlings, finely ground rye, and ground wheat constitute their feed; blue grass and rape, their pasture. We aim to keep them tame and gentle, so that they can be handled at all times, and when farrowing time comes we have no difficulty with our sows; but should any of them have any trouble or fail to raise a good, large, thrifty litter we immediately discontinue her use as one of our brood sows and put her at once in the feed lot for market.

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[a] It is interesting to note that during December, 1902, Mr. Chisholm shipped to South St. Joseph, Mo., a train of nine loads of high-grade Poland China hogs that had been fattened on alfalfa and Kafir corn. Three loads, averaging 272 pounds, topped the market at \$6.47½, selling considerably higher than the tops of the Kansas City and South Omaha markets for the same day. The remaining six loads averaged 223 pounds and sold at \$6.37½. The train was run through from Roswell, N. Mex., to South St. Joseph, in forty hours without loss. It was the first shipment ever made from New Mexico to that market.

T. B. Pearson, Thorntown, Ind.—I desire a diversity of feed, consisting of shorts, oil meal, ground oats, with plenty of grass or forage—such feeds as produce bone and muscle—avoiding corn for brood sows very much, as it produces fat, and fat is not desired in brood sows. In mating, I turn the sow to the boar and allow only one service, then remove the sow and keep her isolated from other hogs until she passes over the heat period, which will not usually last over two days after service.

Davis Bros., Dyer, Ind.—We give them a good pasture or lot that they may get plenty of range, and feed good wheat middlings made into slop, with little or no corn near farrowing time.

Thomas Bennett, Rossville, Ill.—I usually feed some corn and oats before farrowing; the sows run in blue-grass pasture all winter, and I try to make them walk a mile for breakfast, which makes 2 miles every morning. I feed sparingly. Fat brood sows are a curse to anyone.

A. G. Woodbury, Danville, Ill.—Give sows exercise. Keep in fair flesh. Not over one-third of the feed is corn, the balance being oats, shorts, bran, and roots, with clover hay or early cut corn fodder in the spring for spring farrow; for fall farrow keep on grass.

A. J. Lovejoy & Son, Roscoe, Ill.—We feed wheat middlings, ground oats, and pasture in summer; in winter, the same feed, except that we use sugar beets or sorghum for a succulent feed to take the place of pasture. We give plenty of exercise, and separate the sows a week before the time of farrowing.

J. D. Orn, Mount Pleasant, Iowa.—After breeding, the feed consists of corn and oats in equal parts, with plenty of range, and clover hay when they need it. About seven days before farrowing I give them their place for farrowing and a loosening feed.

C. S. Barclay, West Liberty, Iowa.—I give them plenty of exercise on pasture and feed corn lightly, giving a light feed made of wheat shorts or middlings mixed with oats into a thin slop.

O. S. West, Paullina, Iowa.—I feed bran, shorts, and oat siftings, a product of the oatmeal mills. Corn is of secondary importance for breeding stock. I also see that their bowels are in good condition.

W. L. Niles & Son, Ames, Iowa.—Breeding animals are kept separate from the herd and fed a mixed ration. The aim is to supply them with muscle-forming feed and guard against excessive fatness. Some little time before farrowing each sow is given a pen by herself.

W. A. Jones, Van Meter, Iowa.—From breeding until farrowing time I feed 2 parts oats, 1 part wheat (dry), for the morning feed; equal parts by weight of gluten feed, germ-oil meal, shorts, and bran made into a warm slop, for the noon feed, and corn on the cob for the evening feed. I give plenty of good pure water, preferring it warm in cold weather, and give access to salt, wood ashes, and charcoal. The sows should have plenty of exercise, and not too many should be put together. They should have a comfortable sleeping place and should not be disturbed. The sows should be put into the farrowing pens a week before farrowing and fed light feed, but very little if any corn. Use the grass pasture whenever you can.

William D. McTavish, Coggon, Iowa.—My brood sows are fed twice daily. The morning feed consists of one-half wheat middlings and one-half ground oats, with a little oil meal added and thoroughly mixed; for drink, pure water. The evening meal is about five ears of corn to each sow, and pure water. Clover hay is fed every morning.

William B. Lambing, West Liberty, Iowa.—Three weeks before farrowing I feed oats chop once a day, corn once a day, and 1 pint of old-process oil meal once a day.

N. M. Shaffer, Cascade, Iowa.—Sows should have a slop made of mill feed, either bran, shorts, or ground oats, with some oil meal and a little ear corn. I think much of a good pasture. In the first place, a man should not keep too many hogs in one place, and small shoats should not be kept with a lot of old hogs, as they are apt to get crippled or smothered. In breeding hogs a man can not have too many lots, so as to change them often. He should clean the lots often. It is better to plow them and sow some grain; it makes good pasture. I have not lost a sow in farrowing in over ten years.

F. F. Failor, Newton, Iowa.—My sows have a blue-grass pasture of 40 acres in the winter and about 160 acres in the summer, and are fed a mixed ration of ground corn (including cob), with whole oats.

M. H. Donelson, Ogden, Iowa.—This time of the year (spring) the feed is one-third corn, one-third oats, and one-third shorts all ground, mixed, and fed as a rather thick slop. We grind the oats and corn with a seven-horse power gasoline engine, and buy the wheat products. Feed some corn at night when the weather is cold.

Thomas Teal & Son, Utica, Iowa.—We feed very little corn at any time to our brood sows while carrying their young. We make it a point to have them gaining in flesh at the time of breeding, and feed on oats, wheat, rye, and a small amount of ground corn.

R. J. Johnston, Humboldt, Iowa.—Oats and bran. I do not believe in feeding breeding stock much corn; wheat is far better. Corn is all right to finish with.

L. L. Young, Oakland, Nebr.—All my hogs are grown mainly on tame pastures and fed but little grain. For brood sows I select only the best developed, of a feminine type, and strong constitution. From breeding time to farrowing they are fed about equal parts of oats, wheat, and shelled corn, night and morning, and are fed sorghum cane or clover hay at noon; this causes them to take exercise. They are also fed a mixture of salt, ashes, air-slaked lime, and soft coal. Occasionally I give them a little lime in their drinking water, to supply bone-making material for the fetus. Sows are allowed to take exercise up to within two days of farrowing.

C. H. Searle, Edgar, Nebr.—We feed the same as the stock hogs until about two weeks before farrowing, when we put them in a good, warm house and feed slops made of one-third bran and two-thirds shorts, and feed beets twice a week, but no patent stock food.

E. F. Jackson, Malcolm, Nebr.—We feed sparingly of grain, allowing them a run of grass, with plenty of fresh water, shade, and comfortable sleeping quarters. We raise purebred pigs for the trade and want March and April farrow. Our aim is to have the sows in healthy, vigorous condition at breeding time. When the sows are safe in pig, they are divided into small lots of from three to six each. The feed is increased a little as the weather becomes colder, but they are not allowed to get fat and sluggish. We often let them out together in a large field in daytime and put them back in their separate quarters at night. They enjoy the run of the field, hunting about for something they do not have in the lot. Our hogs are fed only at morning and night, and we have come to think it more profitable to use the feeds that can be grown on the farm. The corn is fed shelled to the brood sows in farrow, scattered thinly along the ground, compelling them to eat slowly. We grind corn, oats, and wheat together in equal

parts, and this, with the milk we get and the grass, makes a capital feed for the brood sow and suckling pigs.

S. McKelvie & Son, Fairfield, Nebr.—It is difficult to say here, but sows should have room to exercise at will and should not be too fat at breeding time. After breeding, large numbers should not be kept together, and they should not be fed too liberally on corn or other concentrated feed. It is well if they can have the run of a pasture. Bran and alfalfa are good things to balance their ration.

A. T. Shattuck & Son, Prosser, Nebr.—We feed little corn; all the other grains are good except rye. The sows have alfalfa hay in winter. They have plenty of exercise, good dry sleeping quarters well bedded. Rye straw makes the best bedding.

Charles E. Sutton, Russell, Kans.—My sows are fed principally on mill feed—shorts, middlings, and bran—with practically no corn, and are allowed a large pasture, sowed to rye, rape, or sorghum. About three weeks before farrowing, they are put in separate yards, 20 by 40 feet each, with a 7 by 7 foot house with a board floor and a safety rail 8 inches from the floor.

C. A. Stannard, Emporia, Kans.—I give them the run of a pasture and feed enough to keep them in good, strong condition (not too fat)—a mixed feed made into slop about as thick as porridge. I mix 1 ton of feed as follows: 600 pounds wheat shorts or low-grade flour, 600 pounds ground oats, 200 pounds oil meal, 600 pounds corn chop; mix with water.

J. P. Davis, Fairview, Kans.—At breeding time we separate the brood sows from the others and feed at least one feed of slop, made mostly of bran—two-thirds, and one-third shorts or corn meal. In cold weather this is cooked and fed warm; in warm weather it is soaked for about twelve hours before feeding.

Theo. Louis, Louisville, Wis.—As a rule, we feed 2 parts of shorts to 1 of corn; steam cut clover, mix the above grain with it and feed warm. We feed more or less roots. We separate the old and young sows at feeding time and feed once a day.

George Wylie, Morrisonville, Wis.—During the entire period of gestation our sows are fed on a ration consisting of oats, shorts, and corn in about equal parts, each fed separately; the oats are fed unground and are spread thinly on a tight floor. There are two or three meals or more of roots each week, the amount increasing as farrowing time approaches.

G. W. Plank, Laird, Minn.—I feed a variety of feed, such as corn, oats, and shorts, with a small portion of flaxseed meal, made into a thin slop, with such kitchen slops as are at hand. There is plenty of room for exercise.

Lewis Pond, Churchs Ferry, N. Dak.—I feed bulky feed, such as ground oats, mangel-wurzels, carrots, etc., and am careful not to feed too much greasy kitchen swill, as it will make sows too fat. I see that the sows always have a dry, clean bed. Plenty of exercise is the tonic for health.

G. E. Dykesterhuis, Granada, Colo.—In winter I feed one-half pound ground wheat and one-fourth pound of oats and corn each, ground and mixed into a thick swill, morning and night. I feed sugar beets at noon and as much fourth-cutting alfalfa hay as they will eat clean, with an abundance of fresh water. I give them plenty of exercise and see that their bowels are in good condition. To prepare sows for farrowing (and to keep hogs in condition at any other time), I give them free access to a box of corncob or wood charcoal, mixed with salt and sulphur and sprinkled with a solution of copperas.

James Bolinger, Brush, Colo.—For March pigs I prefer to let the sows have 160 acres or unlimited range, with first-cutting alfalfa cut before blooming, or third cutting, to run to, and give stock barley or corn enough in the evening to keep them thriving. For September pigs my sows have the run of a good alfalfa pasture, with one-half to three-fourths pound of corn soaked and fed at night, so that they will eat it and lie down; otherwise, the green alfalfa seems to carry the corn out undigested.

Stone Brothers, Manhattan, Mont.—We give plenty of exercise by letting them run in a large pasture and giving enough slop and grain in addition to keep them in fair condition.

William Stufft, Kalispell, Mont.—I feed screenings from the elevator, bran and shorts equal parts (dry), with plenty of clear water handy, feeding twice a day. The sows run in pasture and sleep in an open shed on the ground.

G. W. Cooper, Moscow, Idaho.—I give slop and carrots or roots of any kind and plenty of good green pasture, never feeding wheat or corn to sows before farrowing time, as they are more apt to eat their pigs as a consequence of such feeding.

Hazelwood Company, Spokane, Wash.—We give a small grain feed daily, with a feed of roots and beardless barley in the sheaf. Sows are allowed a full run and get plenty of exercise.

John Redmond, McMinnville, Oreg.—I let my breeding sows run on clover pasture or wheat stubble fields, with a feed of chopped oats (two-thirds) and chopped wheat (one-third), night and morning, and plenty of running water.

S. B. Wright, Santa Rosa, Cal.—Young sows that are intended for breeders are fed liberally on grain where they can and will take plenty of exercise; they get green feed or squash, pumpkins, or apples until served and safe in pig. They are usually 8 months old when bred, and weigh 250 pounds or more and have large frames. After this they seldom get any grain until after farrowing, but have good pasture of grass, clover, or whatever I can provide conveniently in the nature of green feed.

Sessions & Co., Los Angeles, Cal.—We have little or no pasture, but intend to keep sows supplied with fresh-cut alfalfa and pumpkins, beets and citrons (stock melons) in their season. We feed skim milk when we have it, and a portion of shorts or ground wheat.

M. H. McCord, Bakersfield, Cal.—I feed sows a liberal mixed ration of shorts and ground oats, which produces a strong, thrifty pig. I keep sows in a thrifty condition, not fat. As this is an alfalfa country, I have had good results from sows which were not fed anything but what they ate in pasture.

Thomas Waite, Perkins, Cal.—When grass is plentiful they run on grass and make their own living on pasture. I find the refuse of fruit a good thing for hogs.

FARROWING TIME.

Sows vary little in the period of gestation. This period is about 112 days from the date of breeding. This date should be known, to avoid mistakes that may result in loss of pigs. As the time for farrowing approaches the sow should be watched carefully, in order that assistance may be given if necessary. If she has already farrowed a litter, and has been properly fed and cared for during pregnancy, little difficulty may be expected. With young sows, par-

ticularly those bred at an immature age, there is a considerable element of risk at this time, not only to the pigs but to the sow herself.

The bedding of a sow at farrowing time should be sufficient only for cleanliness and dryness. If furnished in large amount the pigs will burrow into it and get lost or be crushed. The best bedding is rye straw and wheat straw, and if the straw is cut it makes an almost ideal bed. Chaff is excellent if it can be obtained. Oat straw is not so valuable.

The management of sows during farrowing will depend largely on the animal and on the weather conditions. Assistance should be at hand if needed, but the sow should not be helped if she is getting along nicely alone. Many pigs are lost annually by lack of attention during farrowing; but, on the other hand, there is no doubt that in many cases overanxiety and too much attention may do more harm than good and often result seriously. The assistance that is imperative at this time is to help in cases of difficult labor and to protect pigs from chilling in cold weather. The temperament of the sow should be considered; some are plainly annoyed by the presence of an attendant and show it in their nervous actions; others may be positively ill natured and resent interference. Such sows are better left alone during farrowing, and should be bred to farrow when warm weather may be expected; so that the chances are as much in favor of the pigs as possible. If the sow's nervousness or ill nature leads her to eat her pigs, the best remedy is to put her in the pork barrel at the earliest opportunity.

When farrowing occurs during warm weather, a minimum amount of attention will be needed. The pigs are less likely to become chilled at this season and will generally find their way to the teats unaided. Proper preliminary feeding of the sow and good quarters will make the chance of trouble small. On the other hand, if a sow farrows during extremely cold weather the pigs will be in danger of being chilled unless the house is heated. To remedy this some breeders throw a blanket over the sow until she is through. Others place a few hot bricks or a soapstone in the bottom of a basket or barrel, covering them with straw, and put a cloth over the top to prevent too rapid radiation; and, unless the sow objects too seriously, the pigs are placed in this receptacle as fast as they arrive. They will not suffer if they do not suck for a few minutes, and they will be dry and warm when placed to the teats. This treatment will be necessary even in warm weather with sows that are nervous and move about during farrowing. When farrowing is over the pigs should all be placed to the teats, care being taken that each one gets his share. When the afterbirth is passed it should be removed at once and burned or buried. There is good reason to believe that the eating of the afterbirth is often the beginning of the habit of eating the pigs that is so troublesome with some sows.

In very cold weather it may be necessary for a few days to remove

the pigs to a warm place after they have sucked, to prevent chilling. As new-born pigs suckle as often as every two hours during the day, this entails considerable inconvenience; but it is time well spent and may mean the difference between profit and loss to the breeder. The pigs are soon able to fight their battles with the cold unaided by any but their own warmth and that of the dam.

For the first twenty-four hours the sow should, as a rule, have no food, and will need none. If, however, she shows signs of hunger, a thin slop of bran and shorts or a thin oatmeal gruel may be given. Tepid water should be given to drink as the sow wants it. Never give cold water.

The feeding for the first three or four days should be light and carefully given, and the time consumed in getting the sow on full feed should be from a week to ten days, depending on the size and thrift of the litter. The first feed should be very light, and in the form of a thin, warm slop, such as is mentioned in the preceding paragraph, working gradually to full feed. The pen should be cleaned daily if the sow is confined to it.

OPINIONS OF BREEDERS.

The following were among the replies to the question "What is your management of sows at farrowing?"

George Aitken, Billings Farm, Woodstock, Vt.—In summer all brood sows run to pasture where there is abundance of shade and water; in the winter they are kept in pens with a concrete floor covered with cut-straw litter; have yards for exercise, with a stream of water running over the concrete; are fed very little grain, the feed being principally dairy swill and plenty of beets fed raw.

Smith Harding, Westfield, Mass.—They should be kept by themselves for a few days to get accustomed to their new home. I feed rather light feed a day or two before farrowing and nothing but water for the day after. I also feed rather lightly until the appetite is fully restored, then add milk, if I have it, with middlings, ground oats, and other light feeds.

A. M. Lyman, Montague, Mass.—The sows are divided off into breeding pens about two weeks before farrowing. These pens are 6 by 8 feet, with a railing around the inside 10 inches from the bottom, so that the sow can not lie on the pigs. I bed with shavings.

Richard H. Stone, Trumansburg, N. Y.—I put them in warm pens about 8 by 8 feet, with a fender around the side about 8 inches from the floor; have an attendant with them at farrowing, and always keep a lantern lit at night and hanging in the pen; then the sow will not lie on the pigs.

Edw. Van Alstyne, Kinderhook, N. Y.—The sows have a quiet place by themselves, to which they have been accustomed for at least a week. Not too much of fine, dry bedding. The niches of the pen are protected by planks so that the sow can not lie close to the niche and so lie on the pigs. No feed of any kind is given for at least twenty-four hours after farrowing—just a little warm drink; then light, warm feed in small quantities, until the pigs begin to demand the milk. If constipated, the sow is given one-quarter of a pound of Epsom salts. If the above system is observed, this will not often be necessary.

D. J. Warbasse, Newton, N. J.—Seven to ten days before due shut the sow by herself and give a good bed of straw, so that the pen will be well lined before farrowing. Feed a little corn, with bran and middlings and some roots. At farrowing leave her alone, unless something is radically wrong, and feed lightly for a few days. Do not disturb a sow for say twelve hours.

F. W. Lewis, Chaddsford, Pa.—If the sow is careful, I do not disturb her or feed for twelve and sometimes twenty-four hours; with sows that are not to be trusted, I remove the pigs at once and keep them away until farrowing is over; then let them nurse and put them to the sow every two hours until four days old, when longer periods elapse.

J. S. Burns, Clinton, Pa.—As long as convenient before farrowing each sow has a separate pen and lot (we use portable pens). Never confine her until she begins to make bed to farrow. Everything is made clean and the sow closed in the pen. We treat her in such a way that we can go in the pen and stay with her if need be. No feed of any kind is given for twenty-four hours, then a drink of milk diluted with water. We then begin feeding, lightly at first, and feed for the first four weeks about the same as the four weeks before farrowing. If farrowing comes in April pasture will be at hand and corn may be added, making the ration about 1:6½. When the pigs begin to eat, provide a trough by themselves and feed them skim milk at first, then add oil meal and mill feed.

R. L. Munce, Canonsburg, Pa.—I have them in pens by themselves at least one week before farrowing; put in chaff for bed (not much); put a guard rail around the pens to keep the sows away from the wall and give the pigs a chance to get under; feed lightly at first, increasing the feed as the pigs get older, feeding a slop made of equal parts of bran and shorts (by measure) with one-tenth part (by weight) of oil meal.

John Snowden, Bowie, Md.—My sows are put in warm, sheltered pens, 8 by 16 feet, 8 by 8 feet of which are plank floors, the remainder dirt, about ten days previous to farrowing. They are supplied with leaves and fine straw for bedding, but not too much.

Chas. A. Kuhlmann, Hamilton, Va.—Two or three days before farrowing I put each sow in a pen by herself. The pen is about 8 by 16 feet, divided into two parts, and the sow is allowed to have free access to both. The house has shelves or boards nailed around on the inside from 10 to 12 inches from the floor, projecting about 5 or 6 inches from the walls, thus making an escape for the pigs should the sow get the pigs between her and the house and lie down. I give a liberal amount of wheat straw for bedding and keep a close watch. When I think the sow is about ready to farrow I close her up in the house and arrange to be with her at farrowing. Sometimes she becomes very restless, and in her misery may get up and down very often and hurt her pigs, but when she begins to get restless if rubbed on the breast she will usually lie quietly. As soon as the little fellows are born I break off the navel cords about 2 inches from the body; do not cut. This prevents navel rupture and often saves the life of a pig, as the sow may lie on the long cord and then overlie the pig. After the sow is through farrowing and the afterbirth is thrown away, I leave her. I feed her very lightly for about three days and then begin increasing the feed until she is on full feed again, which is in about ten days. I give the sow her first few feeds in the house, but begin feeding in the pen as soon as conditions are favorable. Clean out the house about three days after farrowing, and see that the sow and pigs have a good, dry bed.

Sam T. Smith, Troy, Ala.—If the weather is rainy and cold I make them a good nest in a stable and put them in there two or three days before due, but if

the weather is good I let them choose their own places in the woods or straw fields. In either case I stay with them until they get through, and always keep a close watch on them for two or three days, hardly ever losing a pig.

W. E. Davis & Bro., Sherman, Tex.—About two weeks before farrowing we put the sow in a pen by herself. In this pen is a good warm house, with straw for a bed. We feed the sow on the kind of feed we want her to have after farrowing, which is corn and shorts slop, both night and morning. Be on hand at the time of farrow to see that all goes well and see that each pig has sucked before we leave. We give the sow nothing to eat for the first twenty-four hours, only water; then give a thin slop and some alfalfa hay to fill up on. We are careful not to feed too much, as this is the most critical time in the pig's life, and if the sow is overfed it causes too large a flow of milk, and this causes scours in the little ones and is often death to them. We have been raising purebred hogs for several years and find that if we can get them two weeks old, we can raise nearly all of them.

M. C. Abrams, Manor, Tex.—Ten days before farrowing I fasten each sow in a pen by herself, about 10 by 20 feet, one-half of which is shedded. Feed a light swill diet until four or five days after farrowing, then increase the feed so as to give the full amount by the time the pigs are 10 or 12 days old. The feed is wheat bran and corn meal for slop—oats and corn for grain.

Clifton Chisholm, Roswell, N. Mex.—As near to farrowing time as possible I put my sows in separate pens which have running water in a trough and are half closed and half open, and feed them a very little slop made of shorts. After farrowing the feed is increased and a little Kafir corn added. About two weeks after farrowing I remove sow and pigs to alfalfa pasture.

H. P. Wilson, Gadsden, Tenn.—I try to get their systems in tiptop shape by farrowing time; they then need very little help through that period. I have never owned a sow that needed any aid, although I always try to be near at hand. After the pigs are dry and suckle I water the sow, and in twelve to eighteen hours give her a good feed of thin slop; in ten days I have the sow and pigs on green pasture.

J. S. Henderson, Kenton, Tenn.—About two or three weeks before farrowing each sow is given a lot to herself, with a comfortable house to sleep in. At farrowing time I watch them very closely until I see that the pigs are sucking all right. I do not get my sows on full feed until the pigs are a week or ten days old, and then feed as before farrowing.

Geo. W. Dozer, Roseville, Ohio.—I feed nothing for the first two days except water with the chill off, after which I add a little wheat bran and increase the rations of bran, middlings, and crushed oats, made into slop and fed in troughs, as much as will be eaten with avidity without dulling the appetite.

N. P. Kershner, Ansonia, Ohio.—One to two weeks before farrowing each sow is placed in a small yard with a farrowing hut, and is watched closely to give assistance if needed. During the first twenty-four hours nothing is given but a drink of water with the chill off; then bran is given in milk or water, at first 1 quart at a feed, increasing to 1 gallon at a feed, twice daily, about a week after farrowing, when a little middlings may be added to the bran. The pigs are watched closely, and if any signs of scours appear the middlings are removed a little longer and then added slowly. At three weeks I can commence to feed one ear of corn twice a day, if the sow has a large litter, increasing as the pigs can stand it. At about five weeks the pigs will begin to look for something to eat, which should be provided where the sow can not molest them. It is a little milk

at first, then a little wheat middlings in the milk, then a little shelled corn for them to crack, keeping up the milk and middlings and increasing the feed as they are able to bear it, but never overfeeding.

F. P. & J. J. Hardin, Lima, Ohio.—About two weeks before farrowing we remove them from the herd to a small lot containing a farrowing house, with a floor in the east end and a large window on the south. The roof is so constructed that we can raise part of the south side to let in the sunshine; we also get the morning sun through the door, and consider sunshine the most essential feature for spring pigs. We feed the sow very lightly for a week or ten days after farrowing, then increasing to full feed.

M. L. Bowersox, Bradford, Ohio.—When the little fellows begin to come I am present with the sow, and as fast as they come place them in a box. When all have come I place them to the sow and help them to suck, putting them back in the box when they have satisfied their appetites, and letting them take a nap. While the little fellows are away from the sow, so that the operation does not disturb her, I break their little teeth with small nippers, so that when they are suckling they will not bite the sow's teats and disturb her; care must be exercised in this that little pieces of the sharp teeth do not go down the throats of the pigs. I then put them to her and make it my business to look after them for a few days; when I hear the sow giving suck, I go and assist the pigs, especially if the litter is large, and by this method I have had sows raise litters of fourteen pigs and all to do well, but they must be helped in the start.

Aaron Jones, jr., South Bend, Ind.—About one week before farrowing each sow is put in a small pen and kept there for one week after, when I turn her and the litter out on grass and let them run together until the sow ceases to look after the pigs, and they wean themselves by natural methods.

Jacob Polley, Union City, Ind.—Most sows will do better at farrowing with no one present. Most persons are too anxious about the sow's welfare and do more harm than good. I have watched many of my sows farrow, and the most good I have done was to see that the coating was removed from the pig's nose so that it could start breathing. If a sow is able to farrow that is the most she needs. A few times when the sow had difficulty I have had to pull the pigs, and in such case the hands are the best instruments I ever saw, as they are not dangerous.

T. B. Pearson, Thorntown, Ind.—One week previous to farrowing time place each sow in good, comfortable quarters, so that she may get accustomed to the same by the time she is due. Handle her often, get her gentle, and feed a slop made of shorts and ground oats, but little corn. Give her a good bed, but not so much that she will pile it up and overlie the pigs. Do not disturb her to feed for eighteen hours after farrowing; let her remain quiet. Feed warm bran slop sparingly for one or two days, as there is great danger at this period of producing too much milk flow and giving the pigs scours.

James D. Kiger, Charlestown, Ind.—After the sows farrow we give no feed of any kind for twenty-four hours, but give all the water the sow will drink, as she is very feverish at this time. From then on we give ground feed made into a slop, the same as before the sow farrowed, a mixture of equal parts of hominy meal and ground oats, or a mixture of 2 parts bran and 1 of shorts, the slop being made thick enough to pour. Feed lightly for the first ten days, to prevent scours in the pigs from too much rich feed. When we are certain that there will be no trouble from this cause we put the sow on a full ration and feed some corn. With this treatment the pigs can be weaned at eight weeks old, when they are ready to go on rye or clover pasture.

Thomas Bennett, Rossville, Ill.—Put them in a single house with plenty of bedding. The quieter they keep the better. If they do not move for a day or two after farrowing so much the better. I have known them to lie in their beds for three days without any feed or water. Feed a little thin shorts slop, as little as possible, so as to keep the sow quiet.

A. J. Lovejoy & Son, Roscoe, Ill.—Give no feed for twenty-four hours, but give them what water they will drink, then commence to feed gradually and increase as the pigs are able to take all the milk the sow gives. After a week give the sow all she can eat of milk-producing feed.

H. M. & W. P. Sisson, Galesburg, Ill.—A few days before farrowing the sows should be put in separate pens, so arranged that they can be turned out every day for exercise. They should be fed moderately on feed that will not constipate them. After the sow has farrowed she should not be fed for perhaps two days, but should be supplied with plenty of water. If inclined to be constipated, a light bran mash fed a few times works very successfully. She should be fed moderately for a few days, gradually increasing the amount up to full feed. She should still have opportunity for daily exercise. When the pigs are about three weeks old they should be fed in an adjoining pen, where the sow can not interfere with them. The sow and pigs should have access to a good pasture as soon as there is grass.

J. D. Orn, Mount Pleasant, Iowa.—Have them in good, dry quarters, watch them closely, and if cold I put a blanket over the sow and pigs until the sow is through pigging. The sow is given a good feed before she commences to farrow.

W. L. Niles & Son, Ames, Iowa.—Each sow is provided with good, dry, comfortable quarters, fed nothing but water for a day after farrowing, and then put on feed gradually, when she is fed all she will eat of corn and sloppy feed largely made up of wheat shorts. In season all sows have the run of pasture.

W. A. Jones, Vanmeter, Iowa.—The sow is put into the farrowing pen a week before farrowing and fed light feed, but very little, if any, corn. The farrowing pen should be dry and clean, with a moderate amount of bedding, which should be changed often. The pen should be arranged to let in the sun when there is any. If the sow is restless and careless, stay with her and take the little fellows away from her and put them into a barrel that has been prepared with some nice dry straw and two or three hot bricks under the straw; cover the barrel, leaving an air hole. When the sow is through her trouble, get nicely acquainted with her and quietly put the little ones with her. If they nurse all right and the sow is quiet and comfortable, go away and let nature do the rest. Do not give the sow anything to eat; give warm water—dishwater is best. On the second day, mix a little bran and shorts with water; the third day the same. Watch carefully whether your sow is a heavy suckler and feed accordingly.

W. M. Lambing, West Liberty, Iowa.—I put each sow in an individual house, to which is attached a small lot. The house is 7 by 8 feet, with fenders around the sides. I try to be with the sow when she farrows, and keep her in the house until the pigs are four weeks old.

F. F. Failor, Newton, Iowa.—Sows are kept in separate pens, as near the ground and as free from drafts as possible. They are fed very lightly from the day of farrow for a few days, with a gradual increase of feed as the pigs grow older. The pigs have plenty of exercise and sunlight, and, above all, a dry and clean bed.

M. H. Donelson, Ogden, Iowa.—I have a house standing north and south, with pens 8 feet square on either side of an alley 4 feet wide. The pens have fenders or pockets around the sides to keep the sow from hurting the pigs. As soon as they get old enough I have them on grass. They must have exercise.

Thomas Teal & Son, Utica, Iowa.—We feed nothing for forty-eight hours, except some weak slop of some kind, putting in a small amount of oil meal, increasing a little every day, with a feed composed of oats, wheat, rye, oil meal, and a small amount of ground corn, fed in slop.

L. L. Young, Oakland, Nebr.—Give nothing but water for the first two days; feed lightly for the first week, then increase to not quite full feed. The sow is kept in a farrowing pen and the pigs allowed to go out and in at will for two weeks, then the sow is turned out for exercise about one hour a day, at which time the pigs are kept in. At this time the sows have access to some green pasture. I do not like to have sows or young pigs out on pasture in cold, rainy time.

C. H. Searle, Edgar, Nebr.—We have them in a good warm pen with a good bed. If the weather is cold we have a stove in the farrowing pen with which we keep the room good and warm. We stay with the sow when farrowing.

J. V. Wolfe, Lincoln, Nebr.—If quiet, attend the sow and remove the pigs to a corner or other place of safety with as little noise as possible until the sow is through. If cold, dry them with a cloth and hand rub them. Clean up the litter, give dry bedding, return the pigs, and assist them to their first dinner.

A. T. Shattuck, Prosser, Nebr.—Put sow in farrowing pen 8 by 8 feet, with fenders around the pen. Be there to take care of the pigs if necessary. Feed lightly for the first few days. Right here is where you must mix in brains.

T. J. Congdon, Pawnee City, Nebr.—About a week before farrowing I shut each sow up by herself so that she will get used to her quarters. I give them plenty of good, clean straw. I know that this is contrary to the ideas of professional breeders, but my experience has been that if you give a sow a good lot of bedding she will pile up her nest and crawl into it, get herself out of sight if possible, and very rarely ever get up or come out until she is through farrowing. They will often lie twelve to sixteen hours without stirring. I always place water where they can get it when they first come out. When you give only a small amount of bedding they are apt to keep getting up and down and often kill their pigs. I give nothing to eat for the first twenty-four hours, then give a little thin slop, increasing gradually until you get her on full feed, which will take from ten days to two weeks, as the pigs begin to draw on the mother. I give them the best and richest feed I can get for them. (Don't change their feed unless you do it very gradually.) I know that this is contrary to the opinions of most breeders. They claim it will give the pigs the scours, but if you will commence slopping the sows before farrowing, and are careful about changing feed and give them a dry, warm place to sleep and keep them out of the damp cold and wet, I will risk the scours. More pigs have scours from having a wet place to sleep than from any other one thing.

S. W. Schooley, Cozad, Nebr.—Put the sows in separate pens a week before the time to farrow. Have the pen about 7 feet square, with fenders around the sides, then when the time for farrowing comes be on hand and look after the little fellows. Put them in a box, keep them warm, and they will soon dry. When the sow is through farrowing put them with her, rubbing her, and see that the pigs get a good dinner.

R. C. Marshall, Arlington, Nebr.—I have the date of breeding and know just when they will farrow. I shut them up two or three days before farrowing. After they farrow, I feed no grain or slops for twenty-four to forty-eight hours, then feed lightly, and get them on full feed in five to eight days. Try to have the sow gentle and quiet and be with her at farrowing. Remove the pigs as fast as farrowed until all arrive, then put each to a teat and see that all nurse and get filled up. Allow very little bedding. Give the sow a warm slop with

just enough bran (say 1 quart) for the first twenty-four hours to sweeten the water, then increase gradually.

H. W. Cheney, North Topeka, Kans.—Have box stalls 8 by 12 feet for each sow. Unless the sow is very large she gets little attention. In the case of big sows, we remove the pigs to a box and keep them there several days, allowing them a chance to suck five or six times a day.

Newton Bros., Whiting, Kans.—Put in clean farrowing pen and keep them quiet. Be on hand to attend to it in person. Never get mad and use them roughly. Never assist unless absolutely necessary, then use judgment and care. Get pigs to nursing, and then clip tusks. Give the sow plenty of pure water but no grain for twenty-four hours. Use common sense and favor nature in every detail possible.

John D. Marshall, Walton, Kans.—Shut her in a warm pen two or three days before farrowing time, giving only a little bedding. Have your sow perfectly quiet, so that you can work with her and the pigs without exciting her. Clean out all the bedding the second day after farrowing, sprinkle the pens well with air-slaked lime, and change the bedding every two or three days.

M. H. Alberty, Cherokee, Kans.—Put sows in a tight 8 by 10 house with fenders; feed nothing for twenty-four hours after farrowing, but give small quantities of lukewarm water often. The second day after farrowing feed lightly on the same kind of feed that the sow was used to before farrowing, and let her out to exercise every day.

L. L. Frost, Mirabile, Mo.—I use a single pen, affording dry, warm quarters. In cold weather I stay with the sow until the pigs have sucked once. Do not feed the sow for twenty-four hours and do not give her all she will eat until the pigs are ten days old.

Evan Davies, Keytesville, Mo.—I have them farrow in 8 by 8 foot pens, using a guard rail fastened 12 inches from the wall and 8 inches high. I use very little bedding until the pigs are a week old, cleaning the pens out daily, using air-slaked lime on the ground before putting fresh bedding down. At farrowing time I feed shorts slop mixed with clear water.

F. M. Lail, Marshall, Mo.—A few days before the sow is due to farrow, I shut her in a small lot attached to the farrowing house and reduce her feed, using only ship stuff and bran, equal parts by weight, mixed with water. Have the bowels loose, and there will be no trouble at farrowing nor danger of the sow eating her pigs. After farrowing, I give nothing but water for twenty-four hours and a very light feed of the swill named for two or three days more; then I gradually increase the feed until the sow is on full feed in a week.

W. O. Wilson, Okemos, Mich.—If the weather is cold, stay right with her and see that the pigs do not chill, but get dry and have something to eat. Give the sow nothing but drink for the first twenty-four hours, and feed sparingly for a week or two, according to the number of pigs in the litter. Increase the feed with the increase of the demands of the pigs on the sow.

W. H. Lessiter, Pontiac, Mich.—I always try to have my sows very tame, so that I can be right in the house with them when they farrow. I use individual hog houses, 6 by 8 feet, with a fender around the inside. If the sow is uneasy when farrowing, I put a board across the house about 2 feet from the back end and resting on the fender; this makes a first-class farrowing pen.

D. S. & F. Smith, Belleville, Wis.—We have a few little houses, 5 by 7 feet, which we consider fine; put the sow in a few days before her time; feed mostly

on slop up to farrowing, then lightly until the pigs begin to draw on the dam, then increase to all she will eat up clean. We feed fine middlings or flour, middlings and bran, or ground barley and oats, each one-half, for slop.

George Wylie, Morrisonville, Wis.—We put them in safety pens that they can not turn around in, thus preventing them from overlying their pigs; as a rule we keep from them and do not offer them anything to eat until they get up and look for it, then give them a drink of thin slop.

F. E. Rutter, Ferryville, Wis.—For the first twenty-four hours I feed only a little bran, say, 1 pint in a gallon of water twice a day; then increase the amount of bran and give oats gradually, getting them on a full feed of bran mash by the time the pigs are a week to two weeks old, according to the size of the sow and the number of pigs, giving all the oats they will eat after their meal of bran mash.

Theodore Louis, Louisville, Wis.—I keep a record of each sow when bred and feed her two weeks before farrowing in her pen alone on the same food that she has been fed up to the time to farrow.

Thomas H. Canfield, Lakepark, Minn.—Keep the sows quiet; have a man in attendance in case of help being needed; in cold weather take away the pigs and keep them warm until all are farrowed; care depends greatly on the temperament of the sow.

C. H. Murphy, Caledonia, Minn.—I prefer to have the sow running around the barnyard or in the pasture until about her time to farrow; sows farrow more easily when they have had plenty of exercise. I put the little ones in a box until the sow is through farrowing, then I bring them back a couple of times to feed before they are left entirely.

O. R. Aney, Wilmot, S. Dak.—The sow is fed on a thin slop composed of shorts and bran from the time of mating to farrowing time. Just before farrowing she receives a liberal feed of oil cake or about a gill of raw linseed oil; this produces an easy farrow. I never feed anything for the first twenty-four hours, but give the sow a drink of water. If she is fed at this time it will cause too large a flow of milk, and the little fellows will not be able to take it all; this will remain in the udder, causing milk fever, and it will also produce white scours in the pigs.

G. E. Dyksterhuis, Granada, Colo.—I place each sow by herself two weeks before farrowing and feed to keep her gaining just slowly up to two days before farrowing, then give her laxative feed and no grain for the next twenty-four hours, then increase the feed slowly. I am always on hand at farrowing and place the pigs to the teats right away, and stay there until the pigs can take care of themselves. I clean the beds twice a day. My farrowing pens are 6 by 8 or 8 by 10 feet, with fenders 6 inches wide placed 6 inches from the floor all around the pens. There is a window on the south side, air-tight, with ventilators to open if necessary. A yard is provided for each sow and litter in winter and pasture in summer. I feed my sows to a certain extent according to the size of the litters they have and the milking qualities they possess. While I never retain a poor milker, still some sows have rich milk while others give a larger amount of poorer quality. I study the characteristics of all my hogs, and breed for the best results as much as possible.

James Bolinger, Brush, Colo.—I have each sow shut up in a pen 8 feet square a few days before she is due to farrow, and try to be around at farrowing until she is entirely through; then I do not feed any for twenty-four hours. When passing I am careful not to disturb her.

William F. Stufft, Kalispell, Mont.—Shut the sow in hog house on floor in stalls 6 by 8 feet, with rails inside 6 inches from the walls and 8 to 12 inches from the floor. Bed with straw or hay; put in fresh bed every other day. Give sow plenty of water; feed sparingly for the first week on bran or oats.

G. W. Cooper, Moscow, Idaho.—I generally give them a good, dry place to themselves a week before the time is up to pig, and feed them swill and roots before farrowing. After farrowing, I feed bran and shorts mixed with the slop or fed wet with water. Keep the sow confined in the pen until the pigs are a month old, but have a hole for the pigs to run out and in for exercise.

Harry McQueen, Pomeroy, Wash.—I shut each sow by herself in a close pen with a good, warm shelter and plenty of dry straw for bedding, and feed them well. When they farrow, I never disturb them until they get up to eat; then give them all they will eat of a sloppy feed of ground grain soaked in water or house slops. Then they will likely be quiet until the next feed hour and are not apt to lie on the pigs or hurt them by getting up and stirring around.

John Redmond, McMinnville, Oreg.—I inclose sows in pens 8 by 10 feet with a 2-by-4 inch scantling around the pen, 8 inches from the floor and 8 inches from the wall, with cut straw or chaff for bedding. The sows are turned out in a lot daily for exercise; if they are watched closely, nearly all the pigs can be saved.

William Durrell, Gresham, Oreg.—When a sow shows signs of farrowing, I am on hand, and as my sows are quiet, I take the pigs as they are farrowed and place them in a box with hot bricks in the bottom, until they are all farrowed and dried off; then I let them all nurse at once.

S. B. Wright, Santa Rosa, Cal.—About one week before farrowing the sow is put into a pen 12 by 24 feet, with a box stall 8 by 12 feet attached. When she is due she is confined in the box stall, if it appears that she is about ready to farrow, and watched. Care is used so to feed that an excessive flow of milk will not be produced. Some pains are also taken to prevent constipation in the sow.

Fred Miller, Dospalos, Cal.—Sows are confined in pens about 8 by 16 feet, without bedding, and are not allowed anything but water for twenty-four hours after farrowing, after which the feed is increased gradually to the desired amount, which is about 2 pounds grain, barley, or wheat mixed with chopped alfalfa hay, and then soaked in skim milk or water. When possible, all the green alfalfa they will eat is added.

M. H. McCord, Bakersfield, Cal.—As a rule, I put the sows in separate pens a few days prior to farrowing, so as to become acquainted with their surroundings. I place a fine quality of hay in the pen, and let them make their own nests, as they know more about such things than I do; this done, they are quite at home. When the little ones come, if any of them are weak, I assist them to get their first feed, and after that everything is plain sailing. I never use violence with my hogs, especially with my brood sows, and I find that there is no domestic animal that responds so quickly to gentleness as the hog. I go among my hogs frequently, talk to them, and keep up a friendly acquaintance with them.

THE SOW A MOTHER.

No time should be lost after farrowing in getting the sow into the open air. Of course, if the pigs were farrowed during the winter months care will be needed, and it may be necessary to let the pigs reach the age of two weeks before turning them out. They can, however, get considerable exercise in the piggery or in the lot with the

sow, and there is often a lot adjoining a barn that is sunny and sheltered from cold winds where the new family may be turned for exercise. Avoid particularly allowing the pigs to run out during a cold rain. They are especially tender during the first weeks.

The appetite for something besides the dam's milk may begin to assert itself by the time the pigs reach three weeks of age. This time will vary, of course, some pigs being more precocious than others. They will be noticed nibbling at grass, rooting a little, and even investigating the sow's feed. A pen should be arranged adjoining that of the dam and separated from it by a partition with sufficient room at the bottom to allow the pigs to run under. In this inclosure put a low, shallow trough and place in it a little skim milk or a thin gruel similar to that recommended for the sow the first day after farrowing. This gruel may be made with any concentrate that is free from woody matter. If ground barley or oats is fed, the meal should be first sifted to remove the hulls. There is a great variety of feeding stuffs that can be used. The main point to be observed is that the pig's stomach is very easily deranged at this age and feeds must be given that will digest readily. The trough in which the pigs are fed should be kept clean. No stale feed should be allowed to remain in it from one feed to the next.

As the pigs learn to eat, the feed may be increased. Skim milk should be used liberally, using rather large quantities at first, from 6 to 12 pounds of milk to each pound of grain. During this period comparatively little corn should be fed, as a rule. More growth can be obtained with a narrow ration, and the corn should be withheld until the fattening period comes. The pigs should be kept growing constantly, and the best results will come with feeding a little under their capacity rather than all they can consume. To counteract the tendency to become too fat, they should have plenty of exercise.

Scours and thumps often cause very serious losses among young pigs. The former is caused usually by overfeeding, by feeding badly spoiled feed, by an abrupt change of feed, or by a change in the feed of the dam that affects her milk. Thumps is generally caused by overfeeding and lack of exercise.

WEANING.

If the pigs have been properly managed for the month after they first begin to eat, and are taking feed in amounts sufficient to make them more or less independent of the sow's milk, weaning will not be a difficult process and will be brought about so that it will be scarcely perceptible, so far as the effects on the pigs are concerned. The time to wean will depend on the way the pigs are eating and the convenience of the breeder. If they are not thoroughly accustomed to a grain and skim milk ration, the time must be delayed, and if there is no occasion for breeding the sow no harm is done by allowing the pigs to run with her to the age of twelve weeks or older.

Breeders differ widely as to the age of weaning. The majority wean at six to ten weeks, with a considerable number at twelve weeks; some older than twelve weeks, and a few younger than six weeks. The 398 breeders of purebred hogs, situated in all parts of the country, who stated definitely the ages at which they weaned their pigs, reported their practice as follows:

As early as 4 weeks of age	13
Not before 6 weeks of age	67
Not before 7 weeks of age	2
Not before 8 weeks of age	161
Not before 9 weeks of age	3
Not before 10 weeks of age	93
Not before 12 weeks of age	59

Those breeders who wean at the age of four weeks are generally in the States classified on page 249 as the East and New England. The breeders who wean at the early periods usually are situated where dairy by-products are plentiful and they usually raise two litters each year, making the demands of the pigs on the sow as brief and light as possible. Breeders in the corn belt wean at the more mature ages, rarely weaning as young as six weeks, and often allowing the pigs to reach the age of sixteen weeks before the sow is taken away. A considerable number of men make no attempt to wean, as the word is generally used—that is, there is no enforced separation of the sow from her pigs; the pigs run with the sow until her instinct tells her that they are old enough to shift for themselves.

The method of weaning will depend somewhat on circumstances. If the pigs are so little dependent on the sow's milk that she is gaining rapidly in flesh and lessening in milk flow, the weaning may be abrupt, the sow being taken away out of hearing. If she is still milking considerably she may be returned to the pigs once a day for two or three days, or the pigs may be taken away in detachments, beginning with two or three of the largest and strongest, then the next strongest, leaving the weakest ones of the litter to complete the drying off.

Whether the weaning is brought about directly or gradually, it should in all cases be complete and decisive. The pigs should be placed apart from the sows in quarters secure enough to prevent communication. By no means should pigs be allowed to follow a sow until she is almost worn out. The pigs are no better and the sow infinitely worse than if weaning had been brought about properly.

OPINIONS OF BREEDERS.

The following were among the replies to the question "At what age and how do you wean your pigs?"

Edward van Alstyne, Kinderhook, N. Y.—If the sow is to be bred shortly, I wean at six weeks; if not, I let them wean themselves. If weaned at six weeks, they should have begun to eat a little with the sow. They will suffer if they have

not done this. Feed small quantities of warm milk with a little middlings or oil meal in it three or four times a day.

E. R. Strawbridge, Moorestown, N. J.—Between six and eight weeks old. Fasten the mother in the pen and let the youngsters in once in a while if the udder cakes. Feed milk in a shallow trough to the little ones.

Tom Frazier, Morgan, Tex.—At two months, little weaning is necessary, as they are eating heavily of bran, oats, and corn. Then put the sows in close pens and leave the pigs where they were.

M. C. Abrams, Manor, Tex.—About eight weeks. When the pigs are from two to three weeks old I have a trough fixed on the outside of the farrowing pens; open a space large enough for them to come through, and feed milk, meal, and anything else that they like to eat. By the time they are seven weeks old they can do without their mother. I then commence decreasing her feed if I want to wean the pigs at this time, and in a week or ten days she will have weaned them. I always try to have an oat pasture for young pigs to go to.

Clifton Chisholm, Roswell, N. Mex.—My pigs have access to a slop of shorts and corn after they are one month old. I take their mothers away at two months.

J. K. Henderson, Kenton, Tenn.—I usually wean my pigs at twelve weeks old and sometimes at ten weeks old by beginning to feed some slops and milk (if I have the milk) at four weeks old, increasing the feed as they get older; by the time mentioned they wean themselves.

L. N. Jordan, Oakland, Ky.—From ten to twelve weeks. After they are four weeks old I feed them in a small trough by themselves, and at the age of ten to twelve weeks take them entirely from the sows.

O. P. McDowell, Plain City, Ohio.—At ten weeks. By that time the pigs are eating by themselves, and I shut the sow away or remove the sow to a distant pasture if possible, but never shut the pigs up. I place a trough where the sow can not get to it, and as soon as the pigs begin to eat, place a little warm milk in the trough and add a little shelled corn. As they get older I add middlings and finely ground oats; and as soon as the pigs are eating nicely I begin to decrease the slop given to the sow and give her more corn and less milk-producing feed. By the time of weaning, the pigs scarcely miss their mother and are not checked in growth.

N. P. Kershner, Ansonia, Ohio.—Ten to twelve weeks; sometimes eight or nine weeks, but ten or twelve is better; by increasing their feed and decreasing that of the sow, taking all her slop feed away from her and increasing her corn. This dries her up. I shut the sow up to dry off and let the pigs run.

Davis Brothers, Dyer, Ind.—With young sows that suckle down thin, we wean at five to six weeks; with others, at seven or eight weeks.

George G. Garretson, Matthews, Ind.—When the pigs are three weeks old, I prepare a pen that the pigs can crawl into but the sow can not. I place in this pen a very shallow trough in which I feed the pigs skimmed milk, being very careful to remove all that is not eaten before it becomes sour. As the pigs learn to eat, I add a little middlings to the milk; also give them some shelled corn. In this way they are fed all they will eat up clean until they are eight weeks old; then I remove the sow out of sight and hearing of the pigs.

W. W. Milner & Son, Thorntown, Ind.—Eight to ten weeks. Take them away from the sow all at once. Sometimes we return them to the sow in twelve or twenty-four hours to let them suck; then they are taken away for all time.

Thomas Bennett, Rossville, Ill.—I generally let the sow wean them, which they will do soon after being in farrow.

A. G. Woodbury, Danville, Ill.—Ten weeks. If not wanting to breed the sow for a fall litter, I do not wean pigs.

C. R. Doty, Charleston, Ill.—Wean at two and a half to three months—on a clover field if in summer and on steamed shorts or middlings if in winter.

William Walker, Pana, Ill.—In my opinion, weaning pigs is quite important. We wean in eight or nine weeks. As soon as the pigs begin to eat, which is quite soon after farrowing, we give them a little ground corn and ship feed, mixed with milk, in a pen by themselves. This pen is fixed so that they can go in and out at will without being disturbed by the sows. In this way they are hearty eaters at weaning time and can be weaned without trouble or backset. This plan also saves the sow, as the pigs do not worry her so much and she will keep in better flesh. She is removed from the pigs every other day when weaning them, so as to dry up gradually. This is done two or three times and the job is then complete.

J. D. Orn, Mount Pleasant, Iowa.—Let the sow wean them.

W. A. Jones, Vanmeter, Iowa.—I generally let the sows wean the pigs, which will be at about ten weeks old.

William D. McTavish, Coggon, Iowa.—I usually let the pigs wean themselves. They will do this if furnished plenty of feed out of reach of the sows.

M. H. Donelson, Ogden, Iowa.—Twelve weeks. Then never allow them to shrink; give the pigs all the milk you think best.

R. J. Johnston, Humboldt, Iowa.—Let the sow wean them.

B. L. Gosick, Fairfield, Iowa.—At ten weeks old I quit slopping the sows and they soon dry off and the pigs are weaned. Never shut the pigs up, and seldom have to shut the sow from the pigs.

S. McKelvie & Son, Fairfield, Nebr.—Teach the pigs to eat as soon as they will by placing tempting feed before them out of reach of the sow. They will then wean themselves at the proper time and never get a check in growth.

Chas. E. Sutton, Russell, Kans.—At eight to ten weeks. Have them all eating well at a separate trough. Take away all but the two smallest; a couple of days later remove one of these, and later the last one.

Evan Davies, Keytesville, Mo.—About twelve weeks, depending largely upon the growth of the pigs and the condition of the sow. I wean my pigs on cowpeas, milk, and a little corn.

Theo. Louis, Louisville, Wis.—We generally let the pigs wean themselves at one hundred to one hundred and twenty days.

A. H. Hendricks, Hazelgreen, Wis.—Ten to twelve weeks old. I shut up the sows; feed on dry oats and water. Let the pigs run at large and they will wean themselves in a few days.

O. R. Aney, Wilmot, S. Dak.—Spring litters at eight weeks and fall litters at ten.

G. E. Dyksterhuis, Granada, Colo.—I feed sows on dry feed from about the eighth or ninth week after farrowing (according to the thrift of the pigs) until they have gradually weaned the pigs in the most natural way without checking the growth of the pigs. I start to induce the pigs to eat at about the third week of age and increase their feed gradually. I avoid any check in the growth of the pigs as much as possible.

S. B. Wright, Santa Rosa, Cal.—Usually let the sows wean them, which generally occurs at eight to ten weeks old. The pigs eat well then and the sows are removed, the pigs remaining where they have been fed.

M. H. McCord, Bakersfield, Cal.—Anywhere between two and three months. I usually make an inclosure of panels to accommodate the number of pigs to be weaned and make an opening large enough for the pigs to get through. In the inclosure I place my troughs and begin feeding with shorts slop or cracked oats slop, and in a short time the pigs are well able to take care of themselves and never stop growing. When they begin to eat well I remove the mothers to another lot.

FEEDING THE PIGS.

Attention will now be given to the pigs that have been weaned. Up to this time all are on the same feed and under the same management. From now on, however, those that are to be retained as breeding animals should be continued on a growing ration—that is, one which is somewhat narrow and will develop bone and muscle to the largest extent; those that are to be fattened for market should be fed more liberally and their feed made more carbonaceous.

THE BREEDING STOCK.

The foundation on which to build up a successful breeding animal is ample range, affording an abundance of exercise, and a rather narrow ration. Growth should be continuous and feed plentiful. The pigs should not be given range so large and so little feed that they will develop nothing but bone; neither should they have so much to eat that they will become indolent and refuse to take the exercise required to develop necessary bone and muscle. Exercise will strengthen the sinews and develop strong muscles, as well as firm joints and strong legs, while a well-filled stomach will nourish these; and from this management we may expect a sow that will be strong, thrifty, and a good breeder, and a boar that will do good work in the herd without breaking down in any respect before he should.

Gilts should not be served before the age of 8 months, bringing the first litter at 12 months. This gives sufficient time for the development of the reproductive organs.

FATTENING.

As soon as it is determined what pigs are to be fed for market their fattening should be started without delay. Experiments have repeatedly proved that young animals always fatten more economically than old ones, and therefore any delay in finishing is accompanied with a loss. In rare instances it may pay to keep a pig over winter as a "store" hog; but generally he loses the flesh he accumulated while suckling his dam, and this can not be replaced except at increased expense. Corn will now come into the ration, and should be supplemented by all the variety of feed at the feeder's command,

to keep the appetite keen and the digestive system in the best condition. This variety should consist of mill feeds, dairy by-products, and succulent feeds, and, according to some authorities, pasture. If skim milk, whey, and buttermilk are at command they can be combined to very good advantage with the ration, commencing with a proportion of about 2 pounds of milk to 1 of grain at weaning time, and reducing the quantity of milk until the pigs are finished on grain alone. A pig gives best returns from dairy by-products while young. The fattening pigs should gain from 1 pound to $1\frac{1}{2}$ pounds daily, and should weigh between 250 and 300 pounds at 9 or 10 months of age. Gains made after this weight are nearly twice as expensive as those made when weighing from 50 to 100 pounds, and a well-bred pig finished at a weight of about 250 pounds will very nearly fill the market requirements and bring a satisfactory price.

SELECTION OF BREEDING STOCK.

The pigs which are to be used for breeding purposes should be selected during the time when the pigs are with the sow. If he is raising hogs for market a breeder will select only sows, castrating all boars. No boar should be used or sold that is not eligible to registry. If the breeder is raising purebred stock the inferior boars will be culled out and castrated, the others being kept for the breeding market.

The selections should be made as early as possible, depending on the skill of the breeder. That noted feeder, the late Mr. William Watson, used to select his show lambs and calves not later than three days of age. He said an animal had all the development of heart and rib at that age that he would ever get, and his results in the show ring bear out the accuracy of his judgment. However, all are not endowed with the keen insight into animal form that Watson possessed. A selection for a breeding animal should not be made unless there are good and sufficient reasons for it, and unless the breeder is quite sure he is right in making the selection. The sows selected should be from large litters and from dams that are good milkers, and of quiet, motherly dispositions.

CASTRATING AND SPAYING.

The boar pigs should be castrated during cool weather, as soon as the testicles descend into the scrotum. An early date is always preferable to a late one; for the development of sex characteristics is of no value to an animal that is intended for meat.

The practice of spaying sows is not very general. It is much more difficult than castration. It often happens that sows which have been impregnated before spaying bear good litters of pigs after that operation.

The age of castration mentioned by correspondents has been tabu-

lated, and it is found that 341 breeders made definite statements, as follows:

At or over 1 week of age	5
At or over 2 weeks of age	40
At or over 3 weeks of age	1
At or over 4 weeks of age	57
At or over 6 weeks of age	66
At or over 8 weeks of age	64
At or over 9 weeks of age	2
At or over 10 weeks of age	26
At or over 12 weeks of age	80

MANAGEMENT OF THE DRY SOWS.

After the pigs are weaned the dry sows should be placed in a pasture by themselves and given very little grain. Those that show themselves to be prolific and good mothers should be retained as breeders; those having a deficient breeding record or being unsatisfactory in any way should be fattened and sold as soon as possible. It does not pay to keep over a year a sow that can not raise a large litter, unless she is purebred and a very exceptional individual.

If a second litter is wanted during a year the sows should be put to the boar during the first heat after weaning. Many breeders do not like to pass many periods of heat for fear that the sows may become "shy," and there is little reason why the sow should not have two litters a year. In any case, the sows should be carried on comparatively light feed until time to breed again, gaining a little in weight; and their treatment after breeding should be as already detailed (pp. 35–45).

MANAGEMENT OF THE BOAR.

The management of the boar has been left until this place in the discussion, not because it is an unimportant subject, but because the sows occupy by far the greatest amount of the breeder's attention; and also because it was assumed at the outset of this discussion that the work of a beginner, with only a group of brood sows, was being outlined.

When the boar arrives at the farm he should be dipped, as a matter of ordinary precaution, against the introduction of vermin. As an additional precaution, a quarantine pen should be ready for him, especially if epidemics are prevalent. In short, he should be treated in much the same manner as has been prescribed for the sows. His feed before change of owners should be known, and either adhered to or changed gradually to suit the new conditions. If he has come a long journey it will be well to feed lightly until he is well acclimated.

His permanent quarters should be a clean, dry, warm, well-lighted, and well-ventilated pen, 10 or 12 feet square, with a yard adjoining where sows may be brought for service. This yard should be large

enough to give him some exercise during the breeding season, when it may be inconvenient to allow him the run of a pasture. Adjoining the yard should be the boar's pasture, from one-half acre to an acre in extent, consisting of clover, alfalfa, or good pasture grasses that thrive in the locality.

Breeders generally advocate the practice of keeping a boar to himself during the entire year—out of sight and hearing of the sows. However, a boar is often allowed to run with the sows after they are safe in pig; but during the breeding season it is by far the best policy to keep him by himself, admitting a sow to his yard for mating, and allowing but one service. This will be productive of the best results in many ways. The energies of the male are not overtaxed. He may thus serve a much larger number of sows, and the litters will generally be larger and the pigs stronger. In the case of a sow that is a somewhat shy breeder and a valuable animal, she may be allowed to remain with a boar during the greater part of her heat; but such instances are exceptional. Another advantage of the single-service system is that a man always has an accurate knowledge of his breeding operations and knows when to expect farrowing time.

The feed of the boar when not in service may be of a succulent nature—mainly pasture and cut green forage during the summer months and roots in winter. A boar can hardly be sustained on this alone, and some grain should be allowed to keep him in condition. This should be nitrogenous in character, consisting of mill feeds—such as shorts, middlings, and bran—some oil meal, and the leguminous grains, with a little corn. As the breeding season approaches, the feed should be increased, so that the boar will be in good condition. While not in service, ample exercise should always be insisted upon, even if it must be urged by the whip. Exercise is productive of well-developed muscles and general thrift; with these two conditions, activity and soundness of reproductive organs will usually follow. During the breeding season it will not be possible for the boar to get the same amount of exercise, and accordingly care must be taken that his energies are not wasted by unnecessary service. Careful feeding will do much to counteract this disadvantage. It must always be remembered that the drains on a boar during service are severe, especially if 50 or 60 sows are served. This will require ample feed, with as much exercise as possible, and, with care in his treatment, will bring about good results. A fully matured boar should not serve more than two sows daily, preferably one in the morning and one in the afternoon, and can serve 50 or 60 in a season without difficulty.

Coburn[a] advises that where farmers own but 12 or 15 sows each, three or four breeders might purchase a boar and use him in common, thus saving materially in expense. Cownie[b] states that he has found

[a] Swine Husbandry, pp. 93, 94.

[b] Kansas State Board of Agriculture, Thirteenth Biennial Report, p. 693.

it well to have at least two boars in the herd, even though the herd be small in numbers.

SANITATION IN THE HOG LOT.

The greatest drawback to the hog industry which breeders in this country have to contend against is the presence of highly contagious diseases known as hog cholera and swine plague, or, popularly, as "cholera," and were it not for the fecundity of these animals their profitable production would be out of the question. These two diseases are so closely identical that post-mortem examinations are usually required to distinguish between them. Indeed, only recently (on October 1, 1903) De Schweinitz and Dorset, of the Bureau of Animal Industry, announced the discovery of a fatal disease of hogs which is caused neither by the hog-cholera nor swine-plague bacilli, and which is apparently a very frequent cause of swine fatalities.

For the present the breeder can regard these diseases as identical, so far as his practical management of the herd is concerned.

There are a few fundamental facts which he must remember if he is to avoid losses by reason of the presence of hog cholera or swine plague in the herd. The first is that they are specific germ diseases, disseminated by bacteria, and the contagion can not be spread from one animal to another or from one herd to another except by these minute organisms. They may be carried in a multitude of ways—by the hogs themselves, on the clothing of persons, on vehicles, in feed, by dogs, birds, and other animals, or by streams. The breeding or feed of a hog can not cause either disease, although bad methods may so weaken constitution and vitality that the animal becomes more susceptible than would otherwise be the case; second, diseases caused by bacteria may be prevented in large part by thorough disinfection; third, bacteria are generally preserved in filth, and, therefore, scrupulous cleanliness will go far toward preventing outbreaks of disease in herds of hogs.

PREVENTION OF DISEASE.

Cleanliness.—Preventive measures must be most relied upon. Hogs must be given dry and well-ventilated quarters, which must be kept clean. Contrary to common belief, hogs have some habits which raise them above other domestic animals from the standpoint of cleanliness. For example, unless compelled to do so, a hog will not sleep in its own filth. If part of the floor of the pen is raised and kept well bedded with straw, while the rest is not, all excrement will be left on the unbedded portion of the floor, and the bed itself will always be clean. Feeding and drinking places should be clean and the water supply pure. Unless the origin is known to be uncontaminated and there has been no possibility of infection during the course, hogs should not be allowed access to streams. Wallows should be kept filled up as much as possible. At least once a month the quar-

ters should be disinfected with air-slaked lime or a 5 per cent solution of crude carbolic acid. If a hog dies from any cause, the carcass should be burned or buried and the pens thoroughly disinfected at once.

Breeding and feeding.—While inbreeding is the surest and quickest means to fix type, the system weakens vitality unless very carefully followed. For this reason closely inbred hogs are more susceptible to cholera than those whose constitutions have not been impaired by the system. The straight corn diet which many hogs receive from one year's end to the other also lessens vitality, and the researches of the Wisconsin Experiment Station have shown that this is probably brought about by actually retarding the development of the vital organs. A minimum of inbreeding and a varied diet, including, especially for breeding stock, ample range, will therefore better enable the herd to resist the attacks of disease.

Isolated houses.—The advantage of a number of small, portable houses, each accommodating a few hogs, rather than one large piggery for the entire herd, has been referred to in the foregoing pages. In districts where cholera is prevalent these are undoubtedly the best shelters. They make it more difficult to carry contagion to all animals in the herd, and the destruction of one of them in case of an outbreak does not entail a great expense. An added advantage is that they may be moved from place to place as needed. While more work is necessary in feeding, the convenience and safety from their use more than offsets this disadvantage.

Quarantine.—Whenever new animals are brought to the farm, or when animals are brought home from shows or from neighboring herds, they should be kept apart from the rest of the herd for at least three weeks. If they have been exposed, the disease will manifest itself within this time, and the sick animals can be treated or killed and disposed of at once.

If cholera breaks out in the neighborhood the farmer should maintain a strict quarantine against the infected herds. He should refrain from visits to farms where they are located and should insist on his neighbors staying out of his hog lots. Intercourse of all kinds at this time should be carefully restricted. The contagion is so easily carried that the strictest measures are justifiable.

TREATMENT OF DISEASES.

As soon as sickness appears in the herd the unaffected hogs should be at once removed to clean, disinfected quarters, preferably without much range; for by running over pastures they may come in contact with contagion. Their feed should be carefully regulated and, if they have previously been on pasture, should include some green feed, roots, or an abundance of skim milk.

The quarters in which the sickness first appeared should be thoroughly cleaned, all bedding and rubbish burned, and loose boards and old partitions torn out and burned. If the pen is old, knock it to pieces and burn it. Disinfect pens and sleeping places, using air-slaked lime on the floors and the carbolic-acid solution on the walls and ceilings. Whitewash everything. If a hog dies burn the carcass or bury it deeply out of the reach of crows, buzzards, or dogs. If possible, do not move the carcass from the place where it falls; but if this can not be done the ground over which it is dragged should be disinfected. Hog cholera bacilli can live in the ground for at least three months. Care must be taken to maintain an absolute quarantine between the sick and well hogs. The same attendant should not care for both lots unless he disinfects himself thoroughly after each visit to the infected hogs. Dogs should be confined until the disease is stamped out.

Treatment of hogs suffering from cholera or swine plague is not always satisfactory. The disease runs its course so rapidly that curative measures are more or less ineffectual, and prevention of an outbreak should be relied upon rather than the cure of sick animals. Dr. Salmon[a] states that the following formula has been successful in less virulent outbreaks when properly administered as soon as signs of sickness are shown:

	Pounds.
Wood charcoal	1
Sulphur	1
Sodium chlorid	2
Sodium bicarbonate	2
Sodium hyposulphite	2
Sodium sulphate	1
Antimony sulphid (black antimony)	1

"These ingredients should be completely pulverized and thoroughly mixed. In case there is profuse diarrhea the sulphate of sodium may be omitted."[a]

A large tablespoonful once a day for each 200 pounds of live weight of hogs to be treated is a dose. The medicine should be thoroughly mixed with the feed, which should be soft, made of bran and middlings, corn meal and middlings, corn meal and ground and sifted oats, or crushed wheat, mixed with hot water. It the hogs are too sick to come to the feed, they should be drenched by pulling the cheek away from the teeth and pouring the medicine in slowly. Care should be exercised, as hogs are easily suffocated by drenching. Do not turn a hog on its back to drench it.[a]

PREVENTION AND DESTRUCTION OF VERMIN.

Hogs often suffer very much from vermin. Lice are introduced from neighboring herds, and the losses in feeding are often severe,

[a] Farmers' Bul. No. 24, U. S. Dept. Agr.

especially among young pigs, when death is sometimes a secondary if not an immediate result. When very numerous, lice are a very serious drain on vitality, fattening is prevented, and in case of exposure to disease the lousy hogs are much more liable to contract and succumb to it.

Vermin are most common around the ears, inside the legs, and in the folds of the skin on the jowl, sides, and flanks. In light and isolated cases they may be destroyed by washing the hogs. In severe cases, however, especially where the whole herd is affected, thorough spraying or dipping should be resorted to. In this case a dipping tank will be a great convenience.

One of the most effective and cheapest preparations to use as a dip is a 2 per cent solution of creolin. The common tobacco dips used for sheep scab are also efficacious. If the hogs are washed, apply the solution with a broom; if they are sprayed, use an ordinary spray pump; for dipping, use a dipping tank. When being washed or sprayed the hogs should stand on a tight board floor.

Newly purchased hogs should be carefully examined for vermin, and they should not be turned with the herd until they are known to be free from these pests.

When the herd is found to be badly infested with lice, all bedding should be burned and loose floors and partitions torn out. Old boards and rubbish should be burned. The quarters should then be thoroughly disinfected by spraying with one of the solutions mentioned. (The creolin solution is good.) After disinfection, as in the case of a disease outbreak, everything about the place, inside and out, should be thoroughly whitewashed.

In these remarks on sanitation no attempt has been made to go into the details of the diseases affecting hogs or their treatment. They are simply intended to call attention to the simple measures which may be used by any farmer to avoid, to a large extent, the decimation of his herd by epidemics. Cleanliness and rational methods of management are relied upon by thousands of farmers to keep their herds in health and vigor. They are the marks of the good farmer and successful hog breeder.

RECENT AMERICAN EXPERIMENTAL WORK.

RECENT EXPERIMENTAL WORK IN PORK PRODUCTION.

INTRODUCTION.

In presenting the following review of experimental work, no attempt is made to give a complete compilation of all the work that has been done in pork production; a résumé of this work would be simply a repetition of what has previously been accomplished in a more thorough manner by others. During recent years, however, the experiment stations have paid a very large amount of attention to this phase of animal husbandry, some of which has the highest value to the producer; and this work has not been compiled heretofore.

In this bulletin complete reviews are given of those experiments only where methods or results are in dispute (such as the relative value of feeding grain whole or ground), or where a practically new feed is being used, to note its effects (such as cotton-seed meal, which heretofore has been regarded as out of the question as a hog feed). Information on grain fed whole or ground and on the feeding of cotton-seed meal is always in order, and their importance, both to the farmer and to the experimentalist, is such that a view of the entire field is necessary to a proper and intelligent discussion of the subject. Where a method has become practically obsolete in hog feeding—such, for example, as cooking—very little recent study has been done by experiment stations.

In studying the results of experimental work it is important to bear in mind that different conditions influence strongly the work of different stations. At the conference of animal husbandry workers in Chicago during the International Live Stock Exposition of 1902, Prof. W. A. Henry called attention to this fact. He pointed out that an "average," to be of any scientific value, should summarize work conducted with all conditions—such as age of animals, breeding, kinds of feed, care, management, and season of the year—as uniform as possible, and should represent the results of the labor of one man conducted at the same station and extending over a very considerable term of years. These factors are all of the highest importance and it is essential that they be considered in studying results. Good feeders know that animals of different ages feed differently, that breed is often an influential factor, that all feeds do not have the same value in the ration, and that good shelter and regular and skillful feeding are highly essential to secure profitable results. It is also readily apparent that, if all other conditions are equal, an experiment conducted in Maine to compare the value of corn meal with that of whole

shelled corn can not be averaged, but only compared, with one of a similar nature conducted in Iowa or Oregon; the factor of climate is important and influential. The results of an experiment with hogs fed in the summer months are not to be averaged with those obtained with similar animals under exactly similar conditions of feed, care, and management during the winter. Even where all conditions are similar and every care has been taken to make them as uniform as possible, seasonal variations of climate may inject another factor of error. The results of two experiments conducted by a corn-belt station, the one during 1901, the other in 1902, could not be averaged with propriety, although they were conducted as uniformly as possible, because the year of 1901 in the central west was one of drought and the summer exceptionally long and hot; whereas weather conditions were exactly the reverse during 1902, when an unusual amount of rainfall was recorded, with very low temperatures during the summer.

Again, though not so frequently recognized, the personality of the experimentalist has a great deal to do with the value of his work. It is unfortunate that frequently a man is placed in a position to conduct experimental work whose qualifications for it are not of the highest order. Results from his work are not so valuable as those from men who combine a large fund of scientific information with an intimate knowledge of the practical care and management of the animals fed.

If the farmer will bear in mind the influence of these modifying conditions, he can better realize the difficulties that surround experimental feeding; he will better understand their value, and will find himself listening more carefully to the advice of experiment station workers, reading bulletins with more confidence, and condemning less hastily what seems to be inaccurate. If each farmer regarded himself, in a way, as an experimentalist and should spend a small amount of time in keeping records of his operations, studying the results with the aid of the information at his command, and if he should at the same time keep in touch with the authorities of his experiment station, there is little doubt that many of the problems now perplexing farmers would be brought much nearer to a solution and the business of feeding live stock rendered more systematic and profitable.

While much may be said against averages, it is a fact that, unless the conditions vary greatly and the extremes are too divergent, a general idea is conveyed by an average that has a practical utility, in that it shows the general results that may be expected to follow certain practices. The averages shown in these pages should be regarded in this light.

As a general rule, the figures given in the following pages relating to experimental work are taken from the station bulletins exactly as they appear in those publications. In some cases obvious typographical errors have been corrected.

PRINCIPLES OF FEEDING.

PHYSICAL CHARACTER OF FEEDS.

Feeds, as regards their physical characteristics, are generally divided into two classes, namely, concentrated feeds, or concentrates, and bulky feeds, commonly called coarse fodder, roughage, or forage. The seeds of plants, whole or ground, and all such feeds as are produced from the by-products of commercial establishments (mills, packing houses, etc.), supply a large amount of nutriment in small bulk, and hence are called concentrates. The body of plants, in the form of hay of all kinds, straw, green fodder, pasture grasses, and roots and tubers, gives us bulky feed or roughage. Vegetables, such as pumpkins, and the waste fruit of orchards are often fed to animals and are in the category of bulky feeds. All of these supply a relatively small amount of nutriment and a large amount of feed material. Milk is, properly speaking, a bulky feed when fed to rather mature animals, particularly when skimmed. For young animals whole milk is the most "complete" feed known, but it is too expensive to feed any but the youngest animals, or those that are to be brought to the highest condition in the shortest possible time.

RELATION OF BULKY FEED TO LENGTH OF ALIMENTARY CANAL.

The amount of bulky feed required is different with different species of animals and depends upon the complexity of the feed of the animal; and the kind and variety of feed in turn have a direct relation to the length and complexity of the alimentary canal. For example, in a state of nature carnivorous animals, such as those of the cat and wolf tribe, have very short and simple alimentary canals, and live upon flesh, which is a very simple diet. Herbivorous animals—that is, those that subsist exclusively upon grasses, browse, etc., such as the horse, ox, sheep, and goat—have the most complicated digestive apparatus and eat a very great variety of feeds. Between these two classes we have those animals that live both on a flesh and a vegetable diet, and with them the alimentary canal is longer and more complicated than that of the carnivora, but shorter and less complicated than that of the herbivora. The pig belongs to this class, which is denominated the omnivora. Domestication has changed the habits of animals considerably, and in so doing has changed the internal characteristics of the body. Domestic dogs and cats have been brought to subsist on a diet in which there is a rather large amount of vegetable matter. Pigs are fed almost exclusively on a vegetable diet and only occasionally indulge their appetite for an animal diet. As a consequence of this variation in the range of feed eaten in domestication, these animals have a longer and more complicated digestive tract than the same species in the wild state.

FUNCTION OF BULK IN THE FEED.

The function of bulk in the feed is more than the mere furnishing of nutriment; for, in a mechanical way, it aids digestion. In the ruminant animals especially there is an enormous stomach content which must be comfortably filled if digestion is to be carried on properly. Hence, with this class of animals a great amount of hay, etc., is required, and they can also give the best returns from a bulky feed and subsist more satisfactorily than any others on hay or straw alone. Pigs require less bulky feed than other domestic animals, but recent experiments show that, to a certain extent, hay feeding is very valuable in pork production. Where herbivorous animals have been maintained for an extended period on feed which was exclusively of a concentrated nature, derangement of digestion has resulted.

CHEMICAL COMPOSITION.

From a chemical standpoint, the constituents of feeds that most immediately concern the feeder are the nitrogenous substances, generally termed protein compounds, which contain a large percentage of nitrogen; the starches, sugars, etc., called carbonaceous substances or carbohydrates, from the fact that they are composed of carbon, with hydrogen and oxygen in the proportions in which they occur in water (they are termed "nitrogen-free extract" in chemical analysis), and fat, found in analysis under the heading of "ether extract." Ash is also of importance and often should be more carefully considered when feeders are making up their rations.

WATER CONTENT.

The most valuable portion of feeds is the water-free substance, or dry matter, of the feed. This is what remains of a feed after heating it in a drying chamber at or near the boiling point until repeated weighings show no change in weight. The amount of water present in feed is obviously an important factor. While water yields neither tissue-building material nor energy, it enters into the composition of the body and is indispensable. When animals are compelled to take into the system water beyond the normal amount, undesirable results will follow. When animals are fed exclusively on roots or skim milk they do not receive more than enough to maintain bodily functions. This is readily understood when we consider that roots contain about 90 per cent and skim milk about 88 per cent of water. On the other hand, hay does not ordinarily contain more than 15 to 20 per cent of water, while grains, leguminous seeds, and milling products contain only about 10 per cent. The water content of feed is very much influenced by weather conditions, especially in the case of roughage, which absorbs large amounts of moisture in wet weather.

ENERGY.

A factor that is being more carefully considered in studying the value of a feed, or a ration, is the amount of energy which it will yield. When feed is utilized in the animal body a certain amount of heat is evolved, the process not being unlike the consumption of fuel in a furnace. This heat is converted into the energy which is necessary whenever work is performed. It is apparent, then, that a horse at hard work will need a ration that will supply more energy than one at moderate or light work. The term work, however, has a wider significance than denoting actual muscular effort in the performance of a task. The operations of mastication, deglutition, and the contraction of the walls of the stomach and intestines involve muscular action, both voluntary and involuntary; in the movements of the heart and lungs and the circulation of the fluids of the body, muscular action of some kind is constantly going on; in fact, the performance of nearly every function of the body is actually some form of work involving the expenditure of energy, accompanied by the evolution of heat and maintained by the energy-yielding material in the feed. The amount of work performed by an animal in the ordinary processes of "hustling for a living"—that is, finding its feed, eating it, and digesting it—is enormous. In experiments, reviewed in the following pages, with suckling pigs, Miss Wilson[a] found that the young animals required nearly as much energy per square meter of surface as had been found by other investigators to be required by a man at hard work. It is therefore readily apparent that the heat-producing powers of feed have a very much more important function than the maintenance of bodily warmth. The unit of energy used in computing the value of a feed from this standpoint is the "small" calorie, which is the amount of heat necessary to raise 1 gram of water 1° C.

Fats yield a greater amount of energy than either the carbohydrates or protein, there being very little less energy given up by proteids when digested than by carbohydrates.

RELATION OF FEED TO THE ANIMAL BODY.

We have seen that the most important constituents of feed are the proteids, the carbohydrates, and the fats. These are practically all that the feeder considers in making up his rations, although the physiologist must consider other compounds which exist in smaller quantities. In the body we find, in the water-free matter, the proteids, the fat, and the ash.

The following table shows graphically the relation between the

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[a] See pp. 232–236.

constituents of the feed and those of the body—that is, the disposition of the feed:

Disposition of feed in the body.

Feed.	Body.
Water	Water.
Proteids	Proteids.
Carbohydrates	Fat.
Fat	Fat.
Proteids (rarely)	Fat.
Ash	Ash.
Fat	Energy.
Carbohydrates	Energy.
Proteids	Energy.

It is seen that the water of the feed reappears as the water in the body. The proteids in the feed form the proteids in the body. The fat of the body is formed from the carbohydrates and fat of the feed and occasionally from the proteids. The ash of the body, such as the mineral matter of the bones, comes from the ash of the feed. The three principal feed constituents—fat, carbohydrates, and protein—yield energy in the order named, fat yielding the most energy for an equal weight of feed. The carbohydrates and proteids are practically equal in heat-yielding power.

Now, as different animals have different demands made upon them, we must expect them to require these constituents of feed in different proportions. To be more explicit, a young and growing animal is building up tissue rapidly, and this should be largely muscular and bony if the best health is maintained. Muscular tissue is largely made up of proteids, and we therefore expect a large amount of protein matter in the feed. There should also be a plentiful supply of mineral matter and phosphates so that the skeleton may be properly built up. As milk is rich in nitrogenous material, we find it an excellent feed for growing animals. Again, animals that are to be fattened rapidly must have a large amount of fat-producing material in the ration, for which reason farmers find corn such a valuable feed for this purpose. Horses that are at hard work require a ration that will give an ample supply of energy. The large amount of energy yielded by fattening rations and heavy-working rations has an interesting bearing on the shelter requirements. Steers that are on full feed can enjoy themselves in the coldest weather if provided with a simple shed that will protect them from cold winds, rain, and snow, and human beings readily recognize the fact that where a large amount of exercise is indulged in, with ample food, a much greater amount of cold may be endured than where no exercise is taken and the ration is light.

DIGESTIBILITY OF FEED.

The amount of nutritive material which an animal can get from his feed is a very important factor. It is obvious that when skim milk or roots are fed alone immense quantities must be eaten to give a sufficient amount of nutritive material. A similar condition is met

with when feeds having a low digestibility are given. For instance, when animals are wintered at straw stacks they acquire large stomachs by reason of gorging themselves with coarse, bulky feed, and generally have a half-starved appearance because they are not able to obtain from such feed an adequate amount of nourishment to maintain flesh and condition. Hay and straw contain large amounts of crude fiber, which is composed of carbohydrate material, largely cellulose, and which is only partially digestible. The crude fiber in grains is insignificant, except in the hulls, and hence their higher digestibility.

THE NUTRITIVE RATIO.

In discussing feeding, the term "nutritive ratio" is frequently met. This means simply the ratio between the total amount of digestible protein in a ration (that is, one day's feed) to the total amount of digestible carbohydrates plus 2.25 times the digestible fat. The fat is of greater value for the purpose of yielding energy than the carbohydrates, and chemists have determined that this ratio is about 2.25; hence the reason for this factor in the computation of a ration. As the functions of the fat and the carbohydrates are very similar, the reason is apparent for the addition of the former. There are many publications available that discuss in detail the computation of rations. One of the principal things to avoid is getting a ration which, while correct, so far as nutritive ratio is concerned, can not be fed successfully on account of its low digestibility or high water content.

PREPARATION OF FEED AND METHODS OF FEEDING.

Investigation of the value of different methods of preparing feed was one of the earliest efforts of the experiment stations made in animal husbandry. The questions that relate to this subject were at once recognized to be of the highest importance and their study very interesting. The subject divides itself into three general sections: (1) Cooking, (2) grinding, and (3) wetting, or soaking.

COOKING.

The utility of cooking feed for animals, and especially for pigs, was given most attention in the days previous to investigations by experiment stations. The subject demands only brief consideration here. Cooking feed is no longer regarded as an economical practice for fattening animals. However, for breeding stock and sick animals, and for animals which it is desired to put into the very highest condition, cooking may be practiced with good results, if expense is disregarded. Pigs so fed show marked thriftiness and health.

GRINDING.

The question whether grain should be fed whole or ground is by no means settled; thus it is one that differs radically from that of cooking, and is of much more importance to feeders.

THE PHILOSOPHY OF GRINDING GRAIN.

The theory of grinding grain is that when the feed is in the condition of a meal it is more readily or quickly available for digestion. It is fallacious to claim that a feed given as meal contains more digestible matter than the same feed before it has been reduced to the condition of meal; for that is a thing that is obviously impossible. But it is not, perhaps, incorrect to say that the digestive fluids may be more effective in their action on feed that has been crushed or ground, and that less undigested matter is voided by the animal than when whole grain is given. The amount of the feed that is absorbed (digested) in its passage through the body, plus the undigested nutrient content of the excrement, practically equals the total digestible matter in the feed before eaten. All practical feeders readily recognize the great possibility of loss by way of the excrement when feeding steers on shelled or ear corn, and, to obviate this, they use hogs to consume the waste. Some waste is inevitable. There can not be perfect feeds or perfect digestions; but we may avoid wasteful methods, and the feeder's problem is to render the loss of feed in the manure as small as possible. It is unnecessary to remark that grain which is swallowed without being masticated is much more likely to pass undigested than if thoroughly masticated before swallowing. The kind of grain that is more readily masticated when fed whole would therefore seem to be less in need of grinding than that which is more generally swallowed without thorough mastication.

EXPERIMENTS TO DETERMINE THE AMOUNT OF UNDIGESTED GRAIN.

The Central Experimental Farm,[a] at Ottawa, Canada, conducted experiments to study this subject with pigs. Whole grain was fed and the excrement was collected for one day, the whole grain in it washed and weighed, the weight per bushel estimated, and the germinating power determined. The following table shows the results:

Loss in feeding whole grain.

Ration.	Amount consumed.	Amount unmasticated.	Estimated weight per bushel.	Germinating power.
	Lbs.	*Lbs. Oz.*	*Lbs.*	*Per cent.*
Oats, soaked 54 hours, all pigs would eat clean, and 3 pounds skimmed milk per head daily	14	2 6	22¼	11
Barley, supplemented as above	17	2 2	35	0
Pease, supplemented as above	17	2	(a)	0
Indian corn, supplemented as above	11	8	40½	8

[a] Amount too small to estimate.

The results of this experiment are very interesting. Note that the amount of grain passed whole is influenced by the size and kind of

[a] Bul. No. 33.

the grain; for example, oats and barley were passed in much larger amounts than pease or corn. However, there was practically no difference in the percentage of loss in weight, and the germinating power of the excreted grains does not seem to have depended on their size. It is interesting to compare these results with the tables in the following pages, which show the results of the experiment station work with grinding grain.

EXPERIMENTS WITH GROUND AND UNGROUND GRAIN.

Ground compared with whole corn.—Numerous stations have reported experiments with ground corn compared with whole shelled corn. There is a considerable amount of variation between them, the results in some cases showing as great a loss from grinding as is gained in others. The following table shows results that have been obtained at experiment stations in various parts of the country. Where corn was fed on the cob the amount is reduced to equivalent weights of shelled corn or not included in the averages:

Results of experiments with ground and unground corn.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Whole grain.	Meal.	Milk.	Whole grain.	Meal.	Milk.
Alabama: [a]		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	2	78	55	21	1.31		182			330	
Whole corn	2	80	28	21	.66	155			536		
Corn meal	2	172	67	21	1.59		216			323	
Whole corn	2	104	36	21	.85	138			384		
Maine: [b]											
Corn meal	3	86	385	196	.65						
Whole corn	3	86	387	196	.66						
Corn meal	3	165	252	84	1.00						
Whole corn	3	165	271	84	1.08						
New York State: [c]											
Corn Meal	4	110	253	63	1.00					269	
Corn on cob	4	112	174	63	.69				401		
Ohio: [d]											
Corn meal, cooked	3	191	404	112	1.20		2,386			590	
Corn on cob, cooked	3	202	167	112	.50	2,109			1,260		
Corn meal	3	205	383	112	1.14		2,116			552	
Whole corn	3	199	404	112	1.20	2,039			505		

[a] Bul. No. 8, Canebrake Sta.

[b] An. Rpts., 1887 and 1888. The rations in the first experiment included raw potatoes and skim milk. Those pigs in the second were fed corn meal and water and corn and water.

[c] An. Rpt., 1893. A supplementary ration to give variety was fed both lots. The "feed per 100 pounds gain" is dry matter.

[d] Sixth An. Rpt. The weights of the feed eaten by the lots fed whole corn in these experiments represented equivalent amounts in shelled corn, the weight of the ear corn being thus reduced to show the actual amount eaten.

Results of experiments with ground and unground corn—Continued.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten. Whole grain.	Meal.	Milk.	Feed per 100 pounds gain. Whole grain.	Meal.	Milk.
West Virginia: *a*		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	6	195	361	28	2.15	------	1,699	------	------	471	------
Whole corn	3	239	141	28	1.68	819	------	------	579	------	------
Corn meal	6	95	581	56	1.73	------	2,384	------	------	410	------
Whole shelled corn, soaked	6	95	555	56	1.65	2,138	------	------	385	------	------
Kentucky: *b*											
Corn meal	2	100	175	63	1.39	------	753	------	------	430	------
Whole corn	2	100	182	63	1.44	780	------	------	429	------	------
Corn meal	3	149	113	28	1.35	------	286	------	------	253	------
Whole corn	3	196	65	21	1.03	357	------	------	549	------	------
Missouri: *c*											
Corn meal	4	160	638	78	2.04	------	3,196	------	------	501	------
Whole corn	4	150	594	78	1.90	2,864	------	------	482	------	------
Corn meal	4	85	250	116	.54	------	1,612	------	------	645	------
Whole corn	4	86	164	116	.35	1,239	------	------	755	------	------
Wisconsin: *d*											
Corn meal	10	255	528	30	1.76	------	2,004	1,002	------	380	190
Whole corn	10	251	420	30	1.40	1,815	------	908	432	------	216
Corn meal	9	346	1,348	70	2.13	------	5,968	------	------	443	------
Whole corn	9	354	1,235	70	1.96	5,947	------	------	481	------	------
Corn meal	10	223	1,076	70	1.53	------	5,236	------	------	487	------
Whole corn	10	225	789	70	1.12	4,665	------	------	591	------	------
Corn meal	9	210	1,348	84	1.79	------	5,956	------	------	442	------
Whole corn	9	212	984	84	1.30	4,926	------	------	501	------	------
Corn meal	7	198	576	63	1.30	------	2,660	------	------	462	------
Whole corn	7	183	552	63	1.25	2,340	------	------	424	------	------
Corn meal	8	187	992	84	1.47	------	4,698	------	------	473	------
Whole corn	8	184	830	84	1.23	4,137	------	------	500	------	------
Corn meal	8	184	1,030	84	1.53	------	4,617	------	------	448	------
Whole corn	8	184	799	84	1.19	3,914	------	------	489	------	------
Corn meal	19	186	2,132	84	1.34	------	10,794	------	------	507	------
Whole corn	19	186	2,136	84	1.34	10,626	------	------	497	------	------
Corn meal	14	175	1,938	98	1.41	------	9,275	------	------	479	------
Whole corn	14	174	1,571	98	1.15	8,778	------	------	559	------	------
Corn meal	12	148	1,038	84	1.03	------	5,745	------	------	553	------
Whole corn	12	145	893	84	.89	5,256	------	------	588	------	------
Corn meal	3	72	218	84	.89	------	979	------	------	449	------
Whole corn	3	70	234	84	.93	1,038	------	------	444	------	------
Corn meal	3	80	166	84	.66	------	961	------	------	579	------
Whole corn	3	80	169	84	.67	1,004	------	------	594	------	------
Corn meal	3	134	274	91	1.00	------	1,407	------	------	513	------
Whole corn	3	133	255	91	.93	1,426	------	------	559	------	------
Average of 19 trials (where total feed is reported) with 297 pigs									524	479	------

a Bul. No. 59.

b Bul. No. 19.

c Buls. Nos. 1 and 10, Agricultural College.

d Fifth and Thirteenth to Nineteenth An. Rpts. In all but the first test meal, such as shorts or middlings, was fed to give variety to the ration and give a good appetite and steady gains. It was in the same proportion to both lots in each test.

The results detailed above show a preponderating amount of evidence in favor of corn meal, judging purely from the basis of feed required for 100 pounds of gain and disregarding the expense of grinding. The average for 19 trials, with 297 pigs, where the amount of feed eaten is reported is 524 pounds of grain required per 100 pounds of gain when corn is fed whole in the form of shelled corn, and 479 pounds when fed ground, a difference of nearly 8.59 per cent in favor of grinding. This is considerably higher than the value usually given for corn meal, and may be explained to some extent by the large amount of feed required to make a given amount of gain in some of the experiments, notably the first at the Ohio Station, which must have been due to extraordinary conditions. Careful researches show that an exact estimate can not yet be made of the comparative value of shelled corn and corn meal. It is worthy of particular attention, however, that in these experiments there were only nine instances out of twenty-six where the value of the two feeds was equal or in favor of whole grain, and in one of the latter, the first Missouri test; although the gains are considerably in favor of the pigs on corn meal, they were more economically made by the pigs on whole corn. The instances that favor whole grain are the Maine experiments, the first in Ohio, the second in West Virginia, the first in Kentucky, the first in Missouri, and the fifth, eighth, and eleventh in Wisconsin.

The researches of Henry in Wisconsin have been the most exhaustive that have been undertaken on this subject. In the Nineteenth Annual Report of the Wisconsin Station he publishes the following summary of seven years' winter feeding "to determine the relative merits of ground and unground corn for fattening hogs." There were 210 hogs fed in all:

Utility of ground grain.

Year.	Number of pigs in each lot.	Average weight at beginning.	Condition at beginning.	Saved or lost.
		Pounds.		
1896	9	350	Thin	8 per cent saved by grinding.
	10	224	Fat	17.6 per cent saved by grinding.
1897	9	211	Rather fat	11 per cent saved by grinding.
	7	190	do	9 per cent lost by grinding.
1898	8	185	do	5.4 per cent saved by grinding.
	8	184	do	8.4 per cent saved by grinding.
1899	19	186	do	2 per cent lost by grinding.
1900	14	175	do	15 per cent saved by grinding.
1901	12	146	do	6 per cent saved by grinding.
1902	6	71	Fair	1 per cent lost by grinding.
	6	80	do	3 per cent saved by grinding.
	6	133	Rather fat	8 per cent saved by grinding.

In these experiments no allowance was made for cost of grinding. In nine cases grinding showed a saving of feed, the highest being 17.6 per cent and the lowest 3 per cent. In the three cases where there was a loss it was 9 per cent, 2 per cent, and 1 per cent, respectively.

Two experiments that have a very close bearing on this subject, but are not included in the above table, are reported from the New Hampshire and Colorado stations.

In New Hampshire Burkett[a] compared the feeding values of corn in ear with that of corn-and-cob meal. The lot receiving whole corn gained an average of 0.81 pound per day, at a cost of 333 pounds grain and 892 pounds skim milk per 100 pounds of gain. The meal-fed lot averaged 0.87 pound daily gain, at a cost of 319 pounds of grain and 855 pounds of skim milk per 100 pounds gain, a difference of 4 per cent in favor of grinding. The Colorado Station[b] made six tests with pigs averaging 62 and 63 pounds to compare ground and whole corn. Those on ground corn made an average daily gain of 0.52 pound, consuming 580 pounds of grain and 90 quarts of skim milk for each 100 pounds of gain. The pigs on whole corn made an average daily gain of 0.44 pound, consuming 670 pounds of grain and 120 quarts of milk for each 100 pounds of gain.

The only definite conclusion that can be drawn from these figures is that it is beyond anyone to say that an advantage may be expected to follow the feeding of corn meal sufficient to pay the cost of grinding. If corn sells on the open market at 50 cents per bushel of 56 pounds and grinding costs from 3 to 5 cents per bushel, a saving of 10 per cent by such methods would be very good economy; but if corn falls to 25 cents the cost of grinding must be lessened to make meal feeding profitable.

Pease.—An experiment with pease is reported from the Central Experimental Farm of Canada,[c] the results of which follow:

Ground compared with whole pease.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
							Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Ground, soaked 54 hours	4	62	224	162	126	1.28	276	468
Whole, soaked 54 hours	4	100	207	107	84	1.27	333	235

This experiment does not show any difference in the feeding value of ground pease as compared with whole pease, so far as daily gains are concerned, but the pigs on ground pease required 17 per cent less

[a] Bul. No. 66.   [b] Bul. No. 40.   [c] Bul. No. 33.

grain than those on whole pease. The results with both feeds were satisfactory.

Grinding small grain.—The amount of material available on the subject of grinding small grain is not so voluminous as that pertaining to corn. In the United States a great amount of the oats, wheat, barley, or rye fed is in the form of mill products and is, of course, ground. These feeds are, moreover, generally used as supplements to corn, and the greater attention has been directed to methods of corn feeding on this account. In common practice, perhaps, these grains are ground more generally than corn, as they are usually much harder. Their greater liability to pass through the animal undigested shows the correctness of such practice.

The following table shows results obtained at five experiment stations, comprising ten tests in all, with a total of 69 pigs:

Effect of feeding ground small grain.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.			Cost per 100 pounds gain.	
						Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Wisconsin:[a]													
Ground oats 1/3, corn meal 2/3	3	-----	457	120	1.27	-------	1,839	-------	-----	403	-------	------	------
Ground oats 2/3, corn meal 1/3	3	-----	371	120	1.03	-------	1,593	-------	-----	429	-------	------	------
Whole oats 1/3, corn meal 2/3	3	-----	296	120	.82	1,457	-------	-------	492	-----	-------	------	------
Whole oats 2/3, corn meal 1/3	3	-----	246	120	.68	1,388	-------	-------	564	-----	-------	------	------
Oregon:[b]													
Chopped oats and wheat	2	151	331	119	1.39	-------	1,603	-------	-----	484	-------	------	5.90
Whole oats and wheat	2	158	308	119	1.29	1,830	-------	-------	594	-----	-------	7.20	------
Utah:[c]													
Chopped wheat, dry	2	126	330	135	1.22	-------	1,421	-------	-----	431	-------	------	------
Whole wheat, dry	2	148	332	135	1.23	1,474	-------	-------	444	-----	-------	------	------
Ontario Agricultural College:[d]													
Ground pease and barley (1:1)	3	107	390	91	1.43	-------	1,589	-------	-----	407	-------	------	3.87
Whole pease and barley (1:1)	3	109	333	91	1.22	1,589	-------	-------	477	-----	-------	4.25	------

[a] Sixth An. Rpt.

[b] Bul. No. 20. In this experiment the pigs were fed on oats alone for two months, and the experiment was concluded with wheat alone.

[c] Bul. No. 70.

[d] An. Rpt., 1891.

Effect of feeding ground small grain—Continued.

Ration.	Number of pigs.	Average weight, beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.			Cost per 100 pounds gain.	
						Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.	Skim milk.	Whole grain.	Meal.
Ottawa:[a]		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Pease, barley, and rye, ground, soaked 12 hours	5	69	104	119	.87	-------	455	-------	-----	436	-------	------	------
Pease, barley, and rye, ground, soaked 12 hours	4	76	134	119	1.12	-------	464	645	-----	346	481	------	------
Pease, barley, and rye, whole, soaked 48 hours	5	69	87	119	.73	386	-------	-------	445	-----	-------	------	------
Pease, barley, and rye, whole, soaked 48 hours	5	69	135	119	1.13	330	-------	1,869	246	-----	1,392	------	------
Oats, pease, barley, and ½ part bran, ground, dry	4	69	126	119	1.06	-------	450	-------	-----	356	-------	------	------
Oats, pease, and barley, whole, dry	4	67	108	119	.90	441	-------	-------	408	-----	-------	------	------
Oats, pease, and barley, ground, soaked 30 hours	4	66	124	119	1.04	-------	467	-------	-----	376	-------	------	------
Oats, pease, and barley, whole, soaked 30 hours	4	66	105	119	.88	409	-------	-------	388	-----	-------	------	------
Oats, pease, and barley, ground, dry	4	101	89	76	1.17	-------	307	-------	-----	343	-------	------	------
Oats, pease, and barley, whole, dry	4	103	82	76	1.08	307	-------	-------	360	-----	-------	------	------
Average, 10 tests, with 69 pigs	---	-----	-----	-----	-----	-------	-------	-------	473	415	-------	------	------

[a] Bul. No. 33, Central Expt. Farm. The mixture of pease, barley, and of rye, and oats, pease, and barley fed in these experiments were composed of equal parts of those grains.

The Colorado Station[a] studied the value of grinding both bald, or beardless, barley and common barley. Four tests were made with bald and three with common barley. The pigs on ground bald barley averaged 60 pounds at the beginning, made an average daily gain of 0.77 pound, and consumed 320 pounds of grain and 100 quarts of skim milk for each 100 pounds of gain. Those on whole bald barley averaged 58 pounds at the beginning, made an average daily gain of 0.65 pound, and consumed 370 pounds of grain and 180 quarts of skim milk

[a] Bul. No. 40.

for each 100 pounds of gain. The pigs on common barley averaged 43 pounds at the beginning. Those on ground grain made an average daily gain of 0.47 pound, and consumed 470 pounds of grain and 90 quarts of milk for each 100 pounds of gain. Those on whole grain made an average daily gain of 0.44 pound, and consumed 520 pounds of grain and 90 quarts of milk for 100 pounds of gain.

These results show a somewhat wider variation between the feeding values of whole and ground small grain than those from the experiments with corn. It should be also noted that the results are much more uniformly favorable to grinding. The approximate averages are 473 pounds of whole grain per 100 pounds of gain and 415 pounds of ground grain per 100 pounds of gain, showing an advantage in favor of grinding of 12.26 per cent.

DRY COMPARED WITH SOAKED FEED.

The general custom of soaking grain has received considerable attention from the experiment stations. In some localities a sentiment in favor of feeding meal dry is gaining ground, and some experiments have shown an advantage for this method of feeding. Pigs have been fed to compare wet and dry meal as follows:

The Indiana Station fed two lots of pigs on a mixture of equal parts of corn meal and shorts, which toward the end of the experiment was changed to hominy meal and shorts. Lot I received dry meal and Lot II received meal mixed with an equal weight of water. Both lots received all the water they desired in addition to that in the feed.

Two tests were made at the Wisconsin Station. In the first a ration of equal parts of corn meal and shorts was fed with water as wanted. In the second trial the grain was 2 parts of corn meal and 1 of shorts. Salt and hardwood ashes were supplied to all lots. In both trials Lot I received dry feed and Lot II wet feed.

In Minnesota 12 pigs were fed a ration of 2 parts of corn meal, 2 parts of shorts, and 1 part of old-process linseed meal. Two lots had their meal mixed into a thick slop with cold water, the others were fed dry.

At the Missouri Station two lots were fed wheat chops and two others a mixture of 4 parts whole wheat and 1 of bran. The wet grain was fed after being soaked thirty-six hours. The pigs, which were high-grade Berkshires, were fed in pens open to the south, and they had access to troughs in which was a mixture of hardwood ashes, coal, and salt.

In Utah three tests are reported. In the first, two lots were fed a ration of equal parts of wheat and bran in yards; in the second, two lots of pigs were fed a balanced ration of corn meal and bran, which was changed in proportion as age and weight increased; the meal to the wet-feed lot was thoroughly mixed with water, but not soaked; in the third experiment, three lots of pigs received a ration of equal parts

by weight of bran and chopped wheat. Lot I received meal that had been soaked twelve hours; Lot II, meal wet just before feeding; and Lot III, dry meal.

The Oregon Station fed 4 well-bred Berkshire pigs, two and one-half months old, at the beginning of the experiment. They received a ration of shorts from July 1 to September 5, and after the latter date a ration of equal parts by weight of chopped wheat, oats, bran, and shorts. The meal to the lot on wet feed was "thoroughly wet with cold water and allowed to stand from one feeding time to the next." Charcoal and ashes were given two or three times each week.

A brief experiment of this character that was conducted by a third-year student as thesis work at the Ontario Agricultural College is noted in the report of that institution for 1900. The hogs in both lots were of similar breeding and were fed a meal mixture of wheat and barley.

The Canada Central Experimental Farm fed four lots of pigs on a mixture of equal parts of pease, barley, and rye as follows: Lot I received whole grain soaked thirty hours, Lot II received whole grain dry, Lot III received ground grain soaked thirty hours, and Lot IV ground grain dry.

The results of all these experiments are shown in the following table:

Results of experiments with dry and wet feed.

Ration.	Number of hogs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Dry.	Wet.	Soaked.	Dry.	Wet.	Soaked.
Indiana: [a]											
Corn meal or hominy meal and shorts, equal parts—		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Dry	4	60	634	146	1.08	2,282			359		
Wet	4	59	645	146	1.10		2,451			380	
Wisconsin: [b]											
Corn meal and shorts, equal parts—											
Dry	3	115	255	68	1.25	1,228			482		
Wet	3	115	337	68	1.65		1,361			404	
Corn ⅔, shorts ⅓—											
Dry	2	169	161	68	1.18	983			611		
Wet	2	169	220	68	1.62		1,040			473	
Minnesota: [c]											
Corn meal 2, shorts 2, linseed meal (O. P.) 1—											
Dry	3	29	246	112	.73	1,085			441		
Do	3	33	249	112	.74	1,141			458		
Wet	3	34	343	112	1.02		1,501			438	
Do	3	30	269	112	.80		1,234			459	

[a] Bul. No 86. [b] Fifth An. Rpt. [c] Bul. No. 22.

Results of experiments with dry and wet feed—Continued.

Ration.	Number of hogs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.			Feed per 100 pounds gain.		
						Dry.	Wet.	Soaked.	Dry.	Wet.	Soaked.
Missouri: [a]											
Wheat chop—		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs*	*Lbs.*
Dry	3	111	562	99	1.89	2,340			416		
Wet	3	112	605	99	2.04		2,420			400	
Whole wheat ⅘, bran ⅕—											
Dry	3	118	414	99	1.39	2,105			508		
Wet	3	119	373	99	1.26		2,054			550	
Utah: [b]											
Wheat and bran, equal parts—											
Dry	2	83	296	112	1.32	1,292			436		
Wet	2	69	311	125	1.25		1,462			470	
Corn meal and bran—											
Dry	3	99	202	75	.90	998			494		
Wet	3	96	171	75	.76		868			508	
Bran and chopped wheat, equal parts—											
Dry	3	91	216	110	.65	1,389			643		
Wet	3	93	271	110	.82		1,422			525	
Soaked	3	86	234	110	.71			1,360			581
Oregon: [c]											
Mixed grain—											
Dry	2	63	453	182	1.24	2,116			467		
Wet	2	61	527	182	1.45		2,320			440	
Ontario Agricultural College: [d]											
Wheat and barley—											
Dry	4			49	1.04				452		
Wet	4			49	.96					489	
Ottawa: [e]											
Pease, wheat, and barley, whole—											
Dry	4	67	432	119	.90	1,764			408		
Wet	4	66	420	119	.88		1,636			388	
Pease, wheat, and barley, ground—											
Dry	4	69	504	119	1.06	1,800			356		
Wet	4	66	496	119	1.04		1,868			376	
Average of 12 tests, with 89 pigs									444	434	

[a] Bul. No. 29. [b] Bul. No. 70. [c] Bul. No. 28. [d] An. Rpt. 1900. [e] Bul. No. 33.

These results show an advantage of slightly over 2 per cent in favor of soaking as compared with feeding dry. The results at Ottawa and in Missouri are worthy of particular notice. Grisdale[a] calls attention to the fact that in the Ottawa experiments a loss is shown by soaking ground grain, but the whole grain returned the better gains when fed soaked, and suggests that the result from soaking meal may not be so marked as from soaking whole grain. The Missouri results

[a] Bul. No. 33, Central Expt. Farm.

seem to present contradictory evidence in the second test, where four-fifths of the ration was whole wheat. The Utah results of soaking the meal twelve hours should be noted. They are not included in the average; if this were done, the balance would be more favorable to dry feeding.

Two experiments carried on at the Illinois Experiment Station[a] to compare soaked and dry shelled corn gave rather indefinite results. Four pigs, fed in pens, were used in each case, 2 being fed on soaked shelled corn and 2 on dry shelled corn. They had no other feed. The first test lasted from April 29, 1889, to May 27, 1889; the second, from June 10 to July 22, 1889. In the second trial the pigs were well fattened when the experiment commenced. Sixty pounds of corn were put in water at one time, at the rate of 1 bushel of shelled corn to about 8 gallons of water, and taken out as needed for feeding. The daily gains favored the pigs on soaked corn in both tests; but in the first test there was an advantage of about 4½ per cent in favor of soaking, while in the second there was an advantage of about 6½ per cent in favor of the pigs on dry corn.

THE EFFECT OF WATER CONTENT OF SLOP.

In Indiana Plumb and Van Norman[b] fed 16 purebred pigs in order to study the effect of water content of slop. The breeds were Chester White and Berkshire. They were divided into four lots of 4 pigs each, with 2 of each breed in each lot. They were of September and October farrow, and the feed was equal parts of corn meal and shorts for the greater part of the experiment. For a time hominy meal was substituted for the corn meal. They were fed as follows: Lot I, dry feed; Lot II, feed mixed with twice its weight of water; Lot III, feed mixed with three times its weight of water. Each lot was given all the water that was desired in addition to that contained in the feed; records were kept of all water drank. Salt and ashes were accessible. Health was good during the entire experiment. The following table shows the results:

Effect of water content of slop fed to pigs.

Ration.	Number of pigs.	Average weight beginning.	Total gain.	Average daily gain.	Feed per 100 pounds gain.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Meal (dry)	4	60	634	1.08	359
Meal 1, water 1	4	59	645	1.10	380
Meal 1, water 2	4	60	651	1.10	374
Meal 1, water 3	4	60	614	1.05	375

Aside from the apparent advantage in favor of dry feeding, at least in this experiment, the water content seems to have very little influ-

[a] Bul. No. 16. [b] Bul. No. 86, Indiana Expt. Sta.

ence on the gains when both rate of gain and feed per 100 pounds of grain are considered.

FERMENTED AND UNFERMENTED BRAN.

Burkett,[a] in New Hampshire, fed two lots (3 in each lot) of Berkshire-Chester White pigs for ninety-nine days in order to compare the effect of fermented bran in a pig's ration. Lot I received fermented bran and skim milk; Lot II received unfermented bran and skim milk. The bran was steamed in a barrel and left for ten days before it was used. The results follow:

Feeding fermented and unfermented bran to pigs.

Ration.	Number of pigs.	Average weight beginning.	Total gain.	Average daily gain.	Feed per 100 pounds gain.	
					Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Fermented bran	3	47	181	0.61	291	906
Unfermented bran	3	48	208	.70	322	923

It is said to be the practice of some New Hampshire farmers to allow bran to ferment before it is fed to pigs, and this experiment was conducted in order to test the value of this practice. The pigs on fermented bran seem to have an advantage in the economy of gain, but their gains were smaller.

WIDE AND NARROW RATIONS.

The Wisconsin Station[b] recently reported four experiments, the object of which was to compare the feeding value of wide and narrow rations. The first compared a ration of equal parts of corn meal and skim milk with one of equal parts of ground pease and wheat middlings plus an equal weight of skim milk. The pigs were Poland Chinas and Large Yorkshires, both breeds being represented in each lot. Each lot had a pen 12 feet square, having a clay floor, and opening into a yard of the same size. Salt and wood ashes were often given.

The second experiment[c] compared a ration of equal parts of corn meal and ground rye with one composed of one-third ground pease and two-thirds wheat shorts. The meal was mixed with water just before feeding and formed a thin slop. The pigs had access to coal ashes and salt, and by subdividing the feeding pens at meal time each pig was fed separately. A pen 12 feet square, with clay floor, and opening into a small yard was allowed each lot. There were 10

[a] Bul. No. 66, New Hampshire Expt. Sta.
[b] Seventeenth An. Rpt.
[c] Eighteenth An. Rpt., Wisconsin Expt. Sta.

pigs—2 Berkshires, 2 Poland Chinas, 2 Yorkshires, and 4 crossbred "razorback" Poland Chinas. These crosses were by an Indian Territory native boar (the typical razorback of the South), out of a "fine-boned, short-bodied Poland China sow." The lots were as equal as possible as regarded size, age, condition, and breed.

In the third experiment[a] pea meal and corn meal were compared. The pigs used were Yorkshires, Berkshires, razorbacks, and crosses of the razorback with Berkshires and Poland Chinas. They were divided into lots as nearly equal in all respects as possible, and were confined in a similar manner to those in the preceding experiment.

The fourth experiment[b] also compared ground pease and corn meal. The pigs were Berkshires, Poland Chinas, razorbacks, and crosses of these lard type breeds with razorbacks. The grain was made into a slop just before feeding time and the pigs were confined in a similar manner to those in the preceding experiment. Each pig had wood ashes and salt and a plentiful supply of water.

The following table shows some of the results of these experiments:

Feeding pigs on wide and narrow rations.

Ration.	Total gain per head.	Average daily gain.	Average daily amount grain eaten.	Feed per 100 pounds gain.	Digestible protein in 100 pounds feed.
Wide ration:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Corn meal and skim milk	158.76	1.26	3.92	632	3.35
Corn and rye meals	80.8	.96	5.3	552	8.9
Corn meal	117.7	.63	3.07	491	7.9
Corn meal	130.8	.62	3.28	606	7.0
Narrow ration:					
Pease, middlings, and skim milk	147.75	1.17	3.94	681	8.85
Pease and shorts	48.4	.62	4.68	762	13.7
Pease	143.1	.75	3.36	452	16.8
Pease	140.6	.84	4.14	495	16.8

Ration.	Digestible carbohydrates in 100 pounds feed.	Digestible fat in 100 pounds feed.	Digestible protein for 100 pounds gain.	Digestible carbohydrates for 100 pounds gain.	Digestible fat for 100 pounds gain.	Nutritive ratio.
Wide ration:	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Corn meal and skim milk	35.85	2.3	33.34	223.41	14.33	1:7.7
Corn and rye meals	67.1	2.7	49.13	370.39	14.90	1:8.2
Corn meal	66.7	4.3	38.789	327.497	21.113	1:9.75
Corn meal	66.7	4.3	47.874	404.202	26.058	1:9.75
Narrow ration:						
Pease, middlings, and skim milk	28.8	1.18	60.14	196.59	8.05	1:3.6
Pease and shorts	50.6	2.7	104.39	385.57	20.57	1:4.1
Pease	51.8	.7	75.936	234.136	3.164	1:3.18
Pease	51.8	.7	83.16	256.41	3.465	1:3.18

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

[b] Nineteenth An. Rpt., Wisconsin Expt. Sta.

During the last two years of the pig-feeding experiments where the comparison of breeds was studied, the Iowa Station[a] fed two lots of similarly bred Duroc Jersey pigs to compare wide and narrow rations. The following table shows the results at this station:

Feeding pigs on wide and narrow rations.

Ration.	Number of pigs.	Average weight beginning.	Total gain.	Number of days fed.	Average daily gain.
Wide:		*Pounds.*	*Pounds.*		*Pounds.*
First experiment	5	38	1,056	153	1.38
Second experiment	5	22	805	163	.98
Narrow:					
First experiment	5	35	967	153	1.28
Second experiment	5	22	746	163	.92

Ration.	Digestible dry matter per 100 pounds gain.	Cost of feed per 100 pounds gain.	Selling price per 100 pounds.	Dressed weight.	Nutritive ratio.
Wide:	*Pounds.*	*Dollars.*	*Dollars.*	*Per cent.*	
First experiment	319	1.84	3.70	79.3	1:7.8
Second experiment	448	2.23	3.55	77	1:7.7
Narrow:					
First experiment	328	1.93	3.70	77.1	1:4.1
Second experiment	487	2.68	3.55	74.1	1:4.9

The most striking feature of these results is the advantageous showing of the pigs on the wide rations. In the Wisconsin tests those pigs on corn meal and skim milk made larger, more rapid, and more economical gains than those on pease, middlings, and skim milk, and the same was true of those on corn meal and rye compared with pease and shorts. The rations were not excessively unbalanced in either case, the wide ones being 1:7.7 and 1:8.2 and the narrow ones 1:4.1 and 1:3.6. In both Iowa experiments there is a decided advantage in favor of the pigs receiving the wide rations. They made the largest and most rapid gains, fed more economically, both in feed eaten and money cost of feed, but sold at the same price on the market. The third and fourth Wisconsin experiments gave better returns for pease alone (a narrow ration) than for corn alone (a decidedly wide ration). These tests show, pound for pound, a greater value for pease than for corn, but it is suggested that, considering market prices of feed, corn is the cheaper. The better appetite of the pease-fed pigs was remarked upon in both tests, but especially in the last one. Some investigators have not found pease to be successful when fed alone. Day[b] states that at Guelph pea feeding resulted in poor gains and unthrifty animals, but feeding a mixture of 3 parts pea meal and 1 part middlings gave good gains and produced excellent bacon.

[a] Bul. No. 48, Iowa Expt. Sta.

[b] An. Rpt. 1899, Ontario Agr. Coll.

The effect of the narrow rations on the external appearance of the pigs was noted in the Wisconsin experiments.[a] Toward the end of the experiment, when pea meal and shorts were compared with corn meal and rye meal, the luxuriant hair and smoother flesh of the pea-fed pigs were remarked upon. The corn-fed pigs were less smooth, had deeper wrinkles, and the flesh showed a tendency to be soft and roll over the shoulders and flanks.

LIMITED COMPARED WITH UNLIMITED RATIONS.

The utility of feeding hogs on a ration which contains a quantity somewhat less than they might consume if the opportunity were afforded has been studied from two standpoints.

THE VALUE OF A SLIGHTLY REDUCED RATION.

Recognizing the necessity, under Canadian conditions, of producing a finished pig of 175 to 190 pounds weight, with a thickness of fat on the back not to exceed $1\frac{1}{2}$ to 2 inches, Grisdale[b] fed three lots of pigs to determine the effect of a slight reduction of the feed. Those of one lot had all the grain they would eat up clean, and the others received somewhat less than this amount. The ration of the one lot was about $4\frac{1}{4}$ pounds of mixed grain and about $3\frac{1}{3}$ pounds of skim milk daily, and that of the others was about 4 pounds of mixed grain and the same amount of skim milk daily. The following table is submitted as a tentative study of the subject:

Effect of a slight reduction in the ration of pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average net gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.	Average amount feed per 100 pounds gain.
		Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Oats, pease, barley, whole; amount limited	4	103	185	82	76	1.08	307	360
Skim milk, limited							254	309
Oats, pease, barley, ground; amount limited	4	101	190	89	76	1.17	307	343
Skim milk, limited							254	285
Oats, pease, barley, $\frac{3}{4}$ ground, $\frac{1}{4}$ whole; amount unlimited	4	103	188	85	76	1.11	326	384
Skim milk, limited							254	299

Although the statement is made that these results are not to be regarded as conclusive, this table affords material for interesting

[a] Seventeenth An. Rpt., p. 18.

[b] Bul. No. 33, Central Expt. Farm.

study. The limited ration lots made better net gains, better daily gains, and pork at a less cost of feed per 100 pounds gain than the unlimited ration lot. The influence of the ground feed on the second lot had, of course, the effect of causing a better showing over the first lot, but this influence of ground feed is not so apparent in the last test.

FEEDING WITH A GREATLY REDUCED RATION.

In Utah, Foster and Merrill made exhaustive studies of the utility of a scanty ration as compared with an unlimited one, and also the value of a period of partial starvation followed by one of unlimited feeding. This is obviously a decidedly different problem from that of the Canadian station. It is held by some feeders that pigs do better on scanty feed than on a liberal supply, and it is also held that when a period of insufficient nourishment is followed by one of full feeding the great gains made on full feed more than compensate for the loss while on the light ration.

The Utah results show the effects of partial-grain rations as compared with full-grain rations during five years while pigs were on pasture; also two years' work showing the effect of full feeding following partial feeding, the pigs having pasture during both tests, and also the effect of full feeding following pasture alone.

The usual plan was to feed one lot of pigs all the grain they would eat without waste; this was known as a "full-grain ration." The "three-fourths ration," "one-half ration," and "one-fourth ration" were computed from the full ration as a standard. These large reductions put the Utah results on a different basis from those of the Canada station.

Effects of partial-grain rations with pasture.—The following table shows the results of the five years' work with pigs receiving full and partial grain rations on pasture:[a]

Feeding pigs on full rations and greatly reduced rations.

Ration.	Total gain.	Average daily gain.	Grain eaten daily.	Grain per 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Full-grain ration	299	1.21	4.56	374
Three-fourths ration	248	1.01	3.64	354
One-half ration	186	.75	2.83	302
One-fourth ration	119	.55	1.35	247

Following a limited ration with full feeding.—Foster and Merrill[a] studied the after effects of partial grain rations by placing pigs on full and partial grain rations for a time, and following this period with one in which all the lots had a full ration.

[a] Bul. No. 70, Utah Expt. Sta.

There were 6 pigs in each lot; they were purebred and high-grade Berkshires, with a few purebred Poland Chinas; were fourteen weeks old when the experiment began, and had run on pasture with their dams. During the experiment they had the run of a good alfalfa pasture. The grain fed was chopped wheat and bran, equal parts by weight.

Lot I received all the grain they would eat.

Lot II received three-fourths as much grain as Lot I.

Lot III received one-half as much grain as Lot I.

Lot IV received one-fourth as much grain as Lot I.

The second period began immediately at the close of the first and continued six weeks. During this period the grain ration was unchanged; the pigs still had the run of pasture, but all the lots received as much grain as they would eat—that is, a full ration.

The following table gives a comparative statement of results for the entire experiment:

Following a limited ration with full feeding.

Ration.	Number of pigs.	Total weight at beginning.	Average daily gain.	Average amount grain eaten daily.	Total feed eaten.	Grain eaten per 100 pounds gain.	Cost per 100 pounds gain.	Profit by periods.	Total profit.
Lot I:		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*	*Dolls.*
First period, full grain ration	6	259	1.18	3.92	1,697	333	2.08	9.77	12.81
Second period, full grain ration	6	786	1.25	6.21	1,697	496	3.10	3.04	
Lot II:									
First period, $\frac{3}{4}$ grain ration	6	259	.914	2.94	1,273	322	2.01	7.86	11.79
Second period, full grain ration	6	654	1.23	5.58	1,507	452	2.82	3.93	
Lot III:									
First period, $\frac{1}{2}$ grain ration	6	260	.685	1.96	849	286	1.79	6.54	10.38
Second period, full grain ration	6	556	1.19	5.31	1,436	448	2.80	3.84	
Lot IV:									
First period, $\frac{1}{4}$ grain ration	6	250	.386	.975	424	254	1.59	4.03	8.19
Second period, full grain ration	6	417	1.12	4.74	1,281	421	2.63	4.16	

It will be seen that during the entire experiment the average daily gain varied with the amount of grain received during the first period; the lots receiving the smallest rations during the first period made the cheapest gains, but the advantage in the total profits is with Lot I.

Full rations after pasture.—The effect of a period of full feeding following one of scanty nourishment is strikingly shown in the Utah results[a] with pigs that went through tests on pasture alone. In 1898

[a] Bul. No. 70, Utah Expt. Sta.

one lot of pigs was on a mixed pasture on which were also some cattle and sheep. A second lot was on alfalfa pasture. No grain was given in either case. The lot on mixed pasture made slight gains. Those on alfalfa changed greatly in appearance during the experiment and lost in weight. At the close of the pasture test the pigs were placed in a pen and fed a full ration of grain and dairy by-products. This second period lasted eight weeks.

In 1899 a similar experiment[a] was conducted, the pigs being on alfalfa pasture. Both lots lost in weight. At the close of the pasture test they were placed in pens and fed all the grain they would eat up clean, having the run of the pasture during feeding times. This period lasted forty-four days. One pig in Lot II failed to thrive and died after the experiment closed. "Postmortem examination showed dry undigested food in the intestines, also the intestines much inflamed."

The following table shows the results of these tests:

Feeding pigs on full grain rations following pasture.

Data.	1898. Lots I and II.	1899. Lot I.	1899. Lot II.
Total weight at beginning .... pounds..	601	172	299
Total weight at close .... do....	1,310	358	486
Total gain .... do....	709	186	187
Days fed .... number..	56	44	44
Average daily gain .... pounds..	2.11	1.41	1.42
Total feed eaten:			
Milk .... do....	4,101		
Whey .... do....	2,751	[a]673	[a]862
Grain .... do....	2,387		
Average amount of feed eaten daily:			
Milk .... do....	12.20		
Whey .... do....	8.19	[a]5.1	[a]6.53
Grain .... do....	7.10		
Feed per 100 pounds gain:			
Milk .... do....	578		
Whey .... do....	388	[a]363	[a]461
Grain .... do....	337		
Cost per 100 pounds gain:			
Milk .... dollars..	.87		
Whey .... do....	.27	2.26	2.89
Grain .... do....	2.11		

[a] Grain only.

These experiments seem to point to two conclusions. In the Canadian results a carefully conducted experiment apparently confirms what has frequently been urged by writers on the feeding of both men and the lower animals, namely, that the digestive system will be kept in better tone and will thus be able to do better work if it is not

[a] See pp. 151, 152 for a detailed abstract of these pasture periods.

crowded to the limit. The great forcing to which animals are subjected during the fattening process must surely have an effect that is similar to that of high living in man, namely, a derangement of the digestive and circulatory organs; and it is beginning to be questioned whether this process of compelling a pig or a steer or a sheep to eat up to his limit twice or three times a day for several months is economical. The pigs on a limited ration in the Canadian experiment received an average daily amount of grain of only about one-half pound less than those that were eating all they would clean up, and ate in seventy-six days a total of only 19 pounds less grain. Yet in one case the average daily gain was better, and in both the gains were made more economically—384 pounds grain and 299 pounds milk being required for 100 pounds gain with the unlimited ration lot, while 343 pounds grain and 285 pounds milk and 360 pounds grain and 309 pounds milk, respectively, were required for 100 pounds gain with the two lots on the limited ration. This would seem to be a subject worthy of further investigation.

The Utah results are decidedly against the system of starving animals at any period of their growth. While the economy of the cramming method of feeding may merely be questioned, no one can doubt that the best results in the fattening of animals will come when they are kept gaining up to the close of the feeding period. These experiments were conducted to test the soundness of the claim made by some feeders that the loss due to feeding and extremely light grain rations is more than made up by the large gains made when the animal is given all the grain it will eat, and that a period spent on pasture with little or no grain feeding distends the stomach of hogs by filling them with a mass of bulky feed, and so prepares them to assimilate feed more readily when placed on a full grain ration, to eat more feed, and consequently to make larger and more economical gains. Practically, they were designed to study the utility of a maintenance ration. In the experiment to study the effect of feeding partial grain rations followed by full feeding (pp. 93, 94), the pigs on a full grain ration during both periods made the greatest gains through the entire experiment; but the feed per 100 pounds gain and the money cost per 100 pounds gain varied directly with the amount of the daily ration, the pigs receiving the smallest amount making the cheapest gains. However, the profits on the feeding were greatest with those pigs that were not stinted in their feed, except in the second period, when the pigs that had been on partial rations showed the largest profits. The economy of feeding during the early months of a pig's life is thus exemplified. With the pigs that were on pasture alone, the same is true; a summer of stagnation was counterbalanced by a short period of heavy feeding, enormous eating, and very large gains that nevertheless were not sufficient to make the entire feeding process economical.

CORN AND CORN SUBSTITUTES.

To the farmer of the corn belt those experiments with grains which may take the place of corn for feeding purposes in times of scarcity are always interesting. In seasons such as that of 1901, when a summer of extreme heat and little or no rain follows a spring of normal conditions, the short corn crop is frequently counterbalanced by a bountiful supply of small grains. Many farmers at such times rely on wheat, barley, oats, and rye to carry their stock to marketable ondition. Outside the corn-growing districts such experiments are of even more importance, for the small grains are often grown in great abundance and form the basis of all rations.

Wheat compared with corn.—At the Indiana Station[a] Plumb and Anderson fed four lots of 4 Chester White pigs to study the relaive value of feeding wheat and corn, both alone and in combination. The pigs were farrowed late in October, and the experiments began as soon as they were weaned, which was early in January. They were out of two sows that were litter sisters. Lot I received whole corn; Lot II received dry whole wheat; Lot III received a ration consisting of equal parts of corn and wheat; Lot IV received soaked whole wheat. Up to March 6 they received 10 pounds of separator milk as a noon eed and after that date 12 pounds of the same daily. They were fed ne hundred and five days. The results were as follows:

Wheat compared with corn for pigs.

ot.	Ration.	Number of pigs.	Weight at beginning.	Weight at close.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.[a]
			Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
...	Corn	4	185	673	105	1.16	312
...	Wheat (dry)	4	175	607	105	1.02	355
I..	Corn and wheat, equal parts	4	174	646	105	1.12	323
7..	Wheat (soaked)	4	189	633	105	1.05	355

[a] Digestible dry matter.

At the Utah Station, Foster and Merrill[b] conducted similar work in omparing ground wheat with corn meal. Two lots of 3 pigs each ere fed, in covered pens, all the ground grain they would eat. The esults follow:

Ground wheat compared with corn meal for pigs.

Ration.	Number of pigs.	Weight at beginning.	Weight at close.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
rn meal	3	290	519	91	0.85	558
ound wheat	3	291	615	91	1.20	464

[a] Bul. No. 67. [b] Bul. No. 70.

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At the usual price of corn and wheat, 75 cents per hundredweight, the cost of gain for the corn-fed lot is given as $4.18 per 100 pounds, and that of the wheat-fed lot at $3.48 per 100 pounds.

At the close of this test a second one was made, but the ration of the first lot was made equal parts of corn meal and pea meal after the middle of the test. The results follow:

Ground wheat compared with corn and pea meals for pigs.

Ration.	Number of pigs.	Weight at beginning.	Weight at close.	Number of days fed.	Average daily gain.	Pounds feed per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
Corn and pea meals	3	260	670	115	1.12	407
Ground wheat	3	257	587	115	.96	403

Wheat compared with various other grains.—At the Nebraska Station, Smith[a] fed eight lots of 6 pigs each to study the comparative feeding value of wheat, rye, and corn, both alone and in combination. Charcoal and lime were fed occasionally. Four pigs in each lot were of the bacon type—Tamworth and Yorkshire—and two were of the fat, or lard, type, or "block" type, as the author expresses it. Each lot had an 8 by 12 foot cement-floored pen in a closed shed, with an 8 by 16 foot yard adjoining. The ground feed was mixed into a thick slop after being weighed; the soaked wheat was weighed before being soaked. The first cost of the pigs was $4.50 per 100 pounds and they were sold on the farm at $5.52½ per 100 pounds. Corn and wheat were charged at 55 cents per bushel, rye at 50 cents per bushel, and shorts at $18 per ton. Grinding was charged at 8 cents per 100 pounds for wheat and rye and 6 cents per 100 pounds for corn. A statement of the results follows:

Wheat compared with other grains for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.	Feed per 100 pounds gain.	Profit per lot.
		Lbs.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Whole wheat, dry	6	110	167.0	342	91	0.63	2,178	637	5.72
Whole wheat, soaked 18 to 24 hours	6	110	174.0	385	91	.70	2,210	575	7.81
Ground wheat	6	108	177.0	414	91	.76	2,317	559	6.43
Ground wheat and corn, equal parts	6	111	178.0	401	91	.74	2,351	586	6.03
Ground wheat and rye, equal parts	6	107	170.7	383	91	.70	2,376	621	4.34
Ground wheat and shorts, equal parts	6	109	174.0	388	91	.71	2,375	612	5.65
Ground corn	6	110	174.5	387	91	.71	2,356	609	3.60
Ground rye	6	107	168.0	367	91	.67	2,290	624	4.55

[a] Bul. No. 75.

In this experiment ground wheat gave the greatest returns for the least amount of grain, but did not return so large a profit as whole soaked wheat, owing to the expense of grinding. The undesirability of feeding whole wheat dry seems to be indicated by these results. Ground wheat and corn gave considerably better returns than ground wheat and rye or ground wheat and shorts. Ground corn and rye alone do not appear to advantage.

These results show wheat to have a feeding value fully equal to that of corn, and are in line with the work that has been previously published on this subject. In the first Utah test, wheat showed a very much better and cheaper gain than corn, but when pea meal was added to the corn-meal ration, wheat did not have so great an advantage. The Nebraska results are specially favorable to wheat feeding.

Feeding frosted wheat.—Nine experiments with wheat that had been more or less damaged by frost were conducted at the Central Experimental Farm of Canada.[a] The grain was fed alone, ground, unground, and in combination with other grains and skim milk.

The following shows the results and conclusions from the experiments:

Frosted wheat for pigs.

Experiment.	Ration.	How prepared.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average net gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.	Feed per 100 pounds gain.
				Lbs.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*
1	Wheat	Ground, soaked 12 hours.	4	185	275	90	77	1.17	479	530
2	do	Whole, soaked 42 hours.	4	186	273	86	77	1.11	570	659
3	Wheat, barley, and pease.	do	4	187	278	92	77	1.19	557	607
4	Wheat	Ground, soaked 12 hours.	5	61	165	104	120	.87	441	423
5	do	do	4	104	192	88	56	1.57	233	265
	Skim milk								1,011	1,251
6	Wheat	Ground, soaked 18 hours.	12	103	187	84	84	1.00	442	526
7	Wheat and barley	Ground, soaked 30 hours.	21	117	179	62	84	.73	326	445
	Carrots								53	85
8	Barley, wheat, rye, and bran.	Ground, soaked 12 hours.	36	54	108	54	105	.51	207	385
9	Barley, rye, wheat, and bran.	do	31	108	191	83	83	1.00	268	323
	Skim milk								250	300

[a] Bul. No. 33.

The fact that this wheat had been injured by frost does not seem to have had a serious effect on its feeding value. In the majority of instances the gains made were satisfactory, and those cases in which a large amount of grain was required for 100 pounds of gain were generally with hogs of considerable maturity and consequently expensive feeders.

Barley compared with corn.—The following results were obtained with barley alone in comparison with corn alone in South Dakota, Colorado, and Canada:

Barley compared with corn for pigs.

Ration.	Number of tests.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.		
							Corn.	Barley.	Milk.
			Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Colorado:[a]									
Whole corn	6	....	71	....	....	0.39	700	....	[e]110
Ground corn	5	....	60	....	....	.46	540	....	[e]110
Whole bald barley	8	....	88	....	....	.58	....	500	[e]130
Ground bald barley	5	....	67	....	....	.74	....	360	[e]80
Whole common barley	4	....	68	....	....	.49	....	540	[e]70
Ground common barley	4	....	47	....	....	.70	....	430	[e]110
South Dakota:[b]									
Corn meal	1	5	126	430	56	1.53	453	....	....
Barley	2	9	112	803	56	1.59	....	457	....
Ontario Agricultural College:[c]									
Corn	....	....	....	....	....	.70	547	....	....
Barley	....	....	....	....	....	1.17	....	456	....
Central Experimental Farm, Ottawa:[d]									
Whole corn	1	3	72	354	91	1.30	290	....	231
Ground corn	1	4	74	392	112	.87	416	....	....
Whole barley	1	4	99	400	84	1.19	....	364	252
Ground barley	1	4	73	444	112	1.00	....	435	....

[a] Bul. No. 40.
[b] Bul. No. 63.
[c] An. Rpts., 1899 and 1900.
[d] Bul. No. 33.
[e] Quarts.

This table does not present an accurate comparison between barley and corn, as skim milk enters into the results in five instances when barley was fed, as against only three instances where corn was fed, but the results command interest in showing that the value of barley for hog feeding compares very favorably with that of corn.

Barley compared with corn, in combinations.—The South Dakota Experiment Station and the Ontario Agricultural College have reported tests with barley in combination with such feeds as shorts and middlings.

[End of Part I.]

The following table shows the results:

Barley compared with corn, with shorts or middlings for pigs.

Ration.	Number of tests.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
							Corn.	Barley.
			Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*
South Dakota: [a]								
Corn and shorts equal parts	2	9	111	840	56	1.67	413	----------
Barley and shorts equal parts	4	17	115	1,561	56	1.64	----------	456
Ontario Agricultural College: [b]								
Corn and middlings	1	11	63	--------	--------	.79	480	----------
Do	1	12	----------	--------	140	.817	432	----------
Do	1	5	55	664	--------	.677	[c]424.55	----------
Barley and middlings	1	13	63	--------	--------	.80	----------	490
Do	1	12	----------	--------	140	.841	----------	450
Do	1	4	42	501	--------	.639	----------	[c]439.22

[a] Bul. No. 63. [b] An. Rpts., 1899 and 1900. [c] Dry matter.

These results are not so favorable to barley as those of the preceding table, but it can also be said, in the light of these figures, that barley is nearly if not quite equal to corn for feeding pigs, judging it solely from the standpoint of rate and economy of gain, and if we take into consideration its effect on the carcass, it far surpasses corn as a high-grade pig feed. An experiment with purebred hogs at the Ontario Agricultural College, which is not included in the foregoing table, compared barley and corn. Some middlings and skim milk were given, but during the last month the grains were fed alone. While receiving middlings and skim milk the pigs on corn made the most economical gains, but after the middlings and skim milk were withdrawn the pigs on barley made the most rapid and economical gains. The experience of this institution places barley at the head of the list of American bacon-producing feeds.

Ground wheat and barley compared with shelled corn.—At the Colorado Station Buffum and Griffith[a] fed two lots of pigs to compare the feeding value of home-grown Colorado grains with corn, which must be imported from States further east. The pigs used were rather ordinary grade Poland Chinas and Berkshires, about eight months old at the beginning of the experiment. One lot was fed shelled corn; the other, a mixture of equal parts of ground wheat and barley. The wheat and barley were grown on the college farm. "The wheat was the common Defiance variety and was grown in a field producing 34 bushels per acre. The barley was of the common hulled variety and was grown in a field that produced 25 bushels per acre."

The pigs were kept in pens of equal size, each pen with a yard

[a] Bul. No. 74.

adjoining. The pens were well bedded with straw. Water was given in abundance and occasionally coal and ashes. The following table shows the results:

Ground wheat and barley compared with shelled corn for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount of feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.	Profit at 7 cents per pound.
						Corn.	Wheat and barley.	Corn.	Wheat and barley.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dols.*	*Dols.*
Corn	4	95	71.25	101	0.70	383.50	....	540	....	7.00	0.95
Wheat and barley	4	94.5	120.25	104	1.16	....	546.50	....	450	4.50	3.90

This experiment shows a mixture of wheat and barley to be much more valuable than corn alone for pig feeding. It also speaks very well for the econony of pork production in those States where corn is not a staple crop. Buffum and Griffith state that it is a common practice in the neighborhood of Fort Collins for farmers to exchange barley or wheat for corn on even terms, and even when corn is high in price and wheat and barley cheaper, they will sell the cheaper home-grown grains and buy the expensive one. They give the average price for ten years of these grains in Colorado as 80.5 cents per 100 pounds for corn, 99.5 cents per 100 pounds for wheat, and 55.1 cents per 100 pounds for barley. They ask, very pertinently, whether Colorado feeders have not the solution of the problem of a supply of concentrates for pork production when home-grown grains sell on the farm for less money per 100 pounds than corn can be purchased in town, and especially when either wheat or barley is equal to corn for this purpose and in combination are superior to it.

Oats compared with corn.—Grisdale[a] reports a comparison of oats and corn. The grain was fed whole and was soaked fifty-four hours before feeding. Both lots received skim milk in addition. The results were as follows:

Oats compared with corn for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
							Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Oats	4	97	170	73	84	0.87	421	345
Corn	3	72	190	118	91	1.30	290	231

[a] Bul. No. 33, Central Expt. Farm.

The results of this test are not very favorable to oats as a pig feed. To get even as economical a gain as could be had from corn a feeder would have to get nearly twice as good gains as from the oats; for, pound for pound of nutrient material, oats is about twice as expensive as corn.

Corn and Kafir corn.—The Oklahoma Station[a] compared Indian corn and Kafir corn as follows:

Six pigs, averaging about 135 pounds at the beginning of the test, were fed six weeks on Kafir heads, and made an average daily gain of 1.11 pounds, requiring about 665 pounds of grain for 100 pounds of gain.

Three pigs, averaging 220 pounds at the beginning, made an average daily gain of 1.53 pounds for thirty-five days, and required the equivalent of 494 pounds of shelled corn for 100 pounds of gain. These same pigs were then fed Kafir meal for two weeks and made 1 pound of gain per head daily, eating 921 pounds of meal for each 100 pounds of gain.

Four pigs, averaging 105 pounds, were fed thirty-five days on Kafir meal. They made an average daily gain of 1.21 pounds, eating 508 pounds of meal for 100 pounds of gain. For the next two weeks they were given soaked shelled corn. They made a total gain of only 30 pounds, eating 707 pounds of corn for 100 pounds of gain. For the next four weeks a daily supply of green alfalfa was given with good effect. A total gain of 140 pounds was made, requiring 365 pounds of grain for 100 pounds of gain.

Kafir corn.—The value of Kafir corn for hogs has been studied extensively at the Kansas Station. Kafir corn was found to have a feeding value considerably below that of corn when both grains were fed alone. In Bulletin No. 95, Cottrell states that the average of a number of trials shows that 527 pounds of Kafir corn and 468 pounds of Indian corn, respectively, are required per 100 pounds of pork made; the yield of pork per bushel of grain being 10.6 pounds in case of Kafir corn and 11.9 pounds with Indian corn. On upland soil, however, the average of eleven years on the Kansas Agricultural College farm shows returns of 46 bushels per acre for Kafir corn and 34½ bushels for Indian corn. Such returns, with gains as noted above, indicate a pork yield per acre of grain at 487 pounds for Kafir corn and 410 pounds for Indian corn. The great value of Kafir corn is its ability to resist drouth.

Soy beans in a Kafir corn ration.—In addition to the lighter returns from Kafir corn than from Indian corn, this grain is very constipating when fed alone, and hogs, especially young ones, tire of it sooner than they do of Indian corn. To remedy these difficulties a mixture

[a] An. Rpt., 1898–99.

is advised, especially with feeds of a laxative nature. One of the most convenient nitrogenous concentrates at the hands of the Kansas farmer is the soy bean. In a series of experiments[a] the effect of such an addition to both Indian corn and Kafir corn rations was studied. The following summary of five experiments shows that soy beans increase gains and diminish the amount of feed required for 100 pounds gain:

Effect of soy beans in a Kafir corn ration for pigs.

Ration.	Average gain.	Increased gain from soy beans.	Feed per 100 pounds gain.	Feed saved by feeding soy beans.
First experiment:	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
Kafir corn meal	90.6		471	
Kafir corn meal 4/5, Soy bean meal 1/5	103.8	14.6	409	13.2
Second experiment:				
Kafir corn meal	102.0		559	
Kafir corn meal 4/5, Soy bean meal 1/5	145.7	42.8	408	27.0
Third experiment:				
Kafir corn meal	74.2		542	
Kafir corn meal 4/5, Soy bean meal 1/5	129.2	74.1	374	31.0
Corn meal	82.6		484	
Corn meal 4/5, Soy bean meal 1/5	120.4	45.5	369	23.7
Fourth experiment:				
Kafir corn meal	52.4		749	
Kafir corn meal 4/5, Soy bean meal 1/5	97.8	86.5	468	37.5
Fifth experiment:				
Kafir corn meal	44.1		653	
Kafir corn meal 4/5, Soy bean meal 1/5	86.6	96.4	435	33.2

The effect of feeding soy beans is good. Hogs receiving them "fatten rapidly, look thrifty, have strong appetites, and the hair and skin are glossy, like those of animals fed oil meal."

The following summary gives a more elaborate comparison of the relative values of Kafir corn or Indian corn meal alone and in combination with soy beans.[a] The results are arranged in order of economy of gains, the total showing the number of pounds of feed required for 100 pounds of gain.

[a] Bul. No. 95, Kansas Expt. Sta.

Value of soy beans in a Kafir corn or Indian corn ration.

Ration.	Feed per 100 pounds gain.	Ration.	Feed per 100 pounds gain.
	Pounds.		*Pounds.*
Corn meal 2/3, soy bean meal 1/3	369	Kafir corn meal, soaked forty-eight hours	542
Kafir corn meal 2/3, soy bean meal 1/3	374	Kafir corn, whole, soaked forty-eight hours	550
Kafir corn meal 4/5, soy bean meal 1/5	408	Kafir corn meal, wet	559
Kafir corn meal 4/5, soy bean meal 1/5	409	Kafir corn, whole, soaked forty-eight hours	632
Kafir corn meal 4/5, soy bean meal 1/5	435	Kafir corn, whole, wet	638
Kafir corn meal 1/2, corn meal 1/2	456	Kafir corn, whole, wet	640
Shelled corn, dry	457	Kafir corn meal, wet	653
Kafir corn meal 4/5, soy bean meal 1/5	468	Kafir corn, whole, dry	655
Kafir corn meal, wet	471	Kafir corn meal, wet	691
Kafir corn meal 1/2, corn meal 1/2, wet	477	Kafir corn meal, dry	749
Shelled corn, dry	479	Average	528
Corn meal, soaked forty-eight hours	484		
Kafir corn, whole, dry	512		
Kafir corn meal and cotton-seed meal	540		
Kafir corn, whole, dry	542		

"The six lots of hogs having soy beans as part of their ration required an average of 411 pounds of grain for 100 pounds of gain, while the 19 lots not fed soy beans required an average of 564 pounds of feed for 100 pounds of gain, an increase in food required of over 37 per cent."

Pease compared with wheat.—The Utah Station[a] compared the values of pease and wheat during two years. The pigs were confined in yards and the grain was given whole and dry. The average of results was as follows:

Pease compared with wheat for pigs.

Ration.	Total weight at beginning.	Total gain.	Feed per 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*
Pease	147	303	452
Wheat	136	282	476

Cowpeas alone compared with corn alone.—At the South Carolina Station[b] Newman and Pickett fed to compare cowpeas with corn. The pigs were from eight to eleven months old and were fed in pens. There were 3 pigs in each lot.

The cowpea-fed lot ate 6.7 pounds of cowpeas per head daily and made an average daily gain for the lot of 3.38 pounds. They required 491 pounds of cowpeas to produce 100 pounds of gain.

The corn-fed lot ate 9.2 pounds of corn per head daily and made an average daily gain for the lot of 4.17 pounds. They required 602 pounds of corn to produce 100 pounds of gain.

With pork at 5 cents per pound and corn and cowpeas yielding 15 bushels and 10 bushels, respectively, per acre, the value of an acre of corn in this experiment was $6.97 and that of an acre of cowpeas $6.12.

[a] Bul. No. 70. [b] Bul. No. 52.

Ground cowpeas and corn meal compared with corn meal.—At the Alabama Station[a] Duggar fed two lots of pigs to compare the relative value of a ration of half corn meal and half ground pease with an exclusive corn-meal ration. The pigs used were placed in covered pens, with small yards adjoining, and, after a preliminary period of a week, put into the experiment which lasted sixty days. The results are as follows:

Ground cowpeas and corn meal compared with corn meal for pigs.

Ration.	Gain.	Number of days fed.	Feed eaten.	Feed per 100 pounds gain.
	Pounds.		*Pounds.*	*Pounds.*
Ground corn alone	68	60	548	806
Corn ½, cowpeas ½	108	60	570	528

In this experiment the cowpea and corn-meal ration made gains 34 per cent more economical than corn alone. The quality of the pork made was as good as that of corn-fed pork.

Peanuts compared with corn meal.—Duggar[a] placed in pens the pigs used to compare the values of peanut pasture and corn meal (see p. 160) to make a more accurate study of the nutritive values of Spanish peanuts and corn meal. The lots received the same rations, except that the peanuts were dry and fed unhulled. The test lasted six weeks with the following results:

Peanuts compared with corn meal for pigs.

Ration.	Number of pigs.	Number of days fed.	Total gain.	Average daily gain.	Feed per 100 pounds gain.
			Pounds.	*Pound.*	*Pounds.*
Peanuts ½, corn meal ½	3	42	84	0.67	370
Peanuts only	3	42	59.5	.47	280
Corn meal only	2	42	8.6	.10	1,070

This experiment shows the best daily gains from the combination of peanuts and corn meal, and shows the best returns for feed eaten by the pigs on peanuts alone. This lot made very much better gains than the pigs fed exclusively on corn meal, which fed very poorly. The pigs on peanuts alone made a gain of 9 pounds per bushel of peanuts. "This gives a value of 27 cents to a bushel of Spanish peanuts when pork is worth 3 cents per pound gross, and 31½ cents when pork is worth 3½ cents per pound." The unthrifty appearance of the pigs fed on corn meal only was commented upon.

At the South Carolina Station, Newman and Pickett[b] fed two lots of grade Berkshire and Duroc Jersey pigs, from eight to eleven months old, in pens, to study the relative values of peanuts and corn. On land of similar character they estimated the corn yield at 15 bushels per acre and peanuts 90 bushels, and in their investigations they found that,

[a] Bul. No. 93.

[b] Bul. No. 52.

with exclusive corn feeding, 602 pounds of corn were required for 100 pounds of gain and with peanuts 443 pounds for 100 pounds of gain. On this basis, an acre of corn will produce 140 pounds of pork and an acre of peanuts 488 pounds, worth, respectively, when pork is 5 cents per pound, $6.97 and $24.37.

COMMERCIAL BY-PRODUCTS.

One of the prominent features of modern industry is the development of the possibilities of the by-product—the waste and offal of manufacturing establishments. Farmers have long appreciated the value of the by-products of flour mills, but of recent years many other materials have come into the market as valuable feed for farm animals. Rice mills, oil mills, and packing houses all have their by-products, which are useful in supplementing the products of the farm.

MILLING PRODUCTS.

The by-products of the flour mills have for years been bought by farmers for use in the feed box, and one of these—middlings—has come to have an unsurpassed reputation for hog feeding, especially for young animals in the early stages of fattening. With the development of milling the ingenuity of the manufacturer has enabled him to throw a host of new foods upon the market. In consequence, we have, in the first place, a by-product more completely deprived of its nutrient material, perhaps, than formerly, but more uniform in quality; and, in the second place, a greater variety of feeds with which to supply the bins. It is not alone the products of the flour mills that have value for feeding purposes. The rice mills, glucose factories, and oil mills all have by-products that are useful adjuncts to feeding operations. Indeed, most of the experimental work of recent years deals with the value of the by-products of these industries. In the majority of instances these feeding stuffs are best used as adjuncts to corn or corn meal, although often the proximity of feed yards to a mill cheapens the by-products sufficiently to enable the feeder to use them as the main part of the ration.

Bran and corn meal compared with corn meal.—Burkett[a] fed two lots of 3 pigs each, one receiving a ration of equal parts of bran and corn meal and milk and the other corn meal and milk. The object was to compare the value of bran in such a ration and have the corn-fed lot as a check. The results follow:

Bran and corn meal compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.	
						Grain.	Milk.
		Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Bran and corn meal	3	47.6	227	99	0.76	308	882
Corn meal	3	47	323	99	1.08	263	663

[a] Bul. No. 66, New Hampshire Expt. Sta.

This experiment gave much better returns for a corn-meal and skim milk ration than for one where bran was added. Burkett does not value bran highly as a pig feed either alone or in combination with corn meal.

Shorts compared with corn.—At the Colorado Station, Buffum and Griffith[a] fed purebred Berkshire pigs about 5 months old to compare the feeding value of corn meal and shorts in combination with wheat, barley, and oats. One lot received shorts, wheat, oats, and barley in rotation—shorts with wheat and oats one day, with wheat and barley the next, with oats and barley the next, and so on. The lot on corn had the same method of feeding and the same ration, except that corn was fed in place of shorts. Feed was charged at the following prices: Corn, 83 cents per 100 pounds; shorts, 75 cents per 100 pounds; wheat, 95 cents per 100 pounds; oats, $1.20 per 100 barley, $1.20 per 100 pounds. The experiment lasted from March 23 to May 31, 1901—sixty-nine days—the results being as follows:

Shorts compared with corn in mixed rations for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.			Feed per 100 pounds gain.	Cost per 100 pounds gain.
						Corn.	Shorts.	Other grain.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	
Shorts and grain	3	112.5	88.2	69	1.31	....	226.5	225.6	521	$4.70
Corn and other grain	3	98	85.6	69	1.27	208.6	....	209.1	487	4.70

At the Indiana Station Plumb and Anderson[b] fed two lots of 3 high-grade Chester White gilts, each five and one-half months old, to compare the value of a ration of corn meal and wheat shorts with a ration of corn meal only. The mixture was equal parts by weight of corn meal and shorts. The pigs were fed in pens with small shelter houses attached. Shorts were valued at $14 per ton and corn meal at $13.50 per ton. The results were as follows:

Feeding value of wheat shorts.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.	Cost of feed per 100 pounds gain.
						Shorts.	Corn meal.		
		Pounds.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Pounds.*	*Dollars.*
Shorts and corn meal	3	129	354	70	1.69	718	718	406	2.74
Corn meal	3	129	327	70	1.56	....	1,413	432	2.80

The mixture of corn meal and shorts gave larger, more rapid, and more economical gains than a ration of corn meal only. In the Colo-

[a] Bul. No. 74.

[b] Bul. No. 71.

rado experiments the pigs fed on a ration of shorts made larger and more rapid gains than those on corn meal, but they required more feed per 100 pounds gain.

Corn meal compared with rice meal.—The South Carolina Station[a] compared rice meal and corn meal. "The rice meal is a by-product of the rice mills and consists largely of rice flour, rice polish, and rice bran. As yet the mills have no uniform way of putting it on the market, and, in order that the reader may understand what is meant by rice meal, as used in this experiment, it may be said that it is all the by-product obtained in cleaning the rice grain for the market. Its chemical composition shows that it has about the same amount of protein, carbohydrates, and fat as corn meal."

The pigs used were Berkshires, about five months old, weighing about 90 pounds each. They were given a ration consisting of 1 part meal and 4 parts skim milk, the milk being mixed with the meal, and were confined in pens 20 by 40 feet, with plenty of shade.

The experiment was divided into two periods. During the first period of thirty-nine days Lot I was fed the corn-meal ration and Lot II the rice-meal ration; during the second period of twenty-two days the feed was reversed, Lot I having rice meal and Lot II corn meal.

The results during the first period were not decisive, but during the second they were somewhat favorable to the rice meal.

The results for each kind of grain for the entire experiment are as follows:

Rice meal compared with corn meal for pigs.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost of feed per 100 pounds gain.
					Meal.	Milk.	Meal.	Milk.	
		Lbs.		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dollars.*
Rice meal 1 part, skim milk 4 parts	3	314.5	61	1.72	779	3,116	248	991	3.84
Corn meal 1 part, skim milk 4 parts	3	303	61	1.66	779	3,116	257	1,028	4.63

The corn meal was valued at $20 per ton, rice meal at $15 per ton, and skim milk at 20 cents per 100 pounds. This experiment shows that rice meal, such as was used in this test, is fully as valuable as corn meal in pig feeding and corroborates previous work along this line.

Feeding value of rice polish.—Owing to the high price of corn during 1902, Duggar[b] devoted considerable attention to the investigation of the value of those feeds whose composition seemed to indicate that

[a] Bul. No. 55.

[b] Bul. No. 122, Alabama Expt. Sta.

they could be used as substitutes for corn meal in pig feeding. In this connection rice polish was fed to a number of pigs under different conditions. Rice polish is a by-product of the rice mills and is difficult to obtain in some sections of the country, as millers often mix it with less valuable by-products and sell the mixture under the name of "rice meal." For this reason rice meal is said to be a variable and uncertain quantity and all samples do not have equal feeding value. In 1902 rice polish was quoted by a Savannah mill at $17.90 per ton, delivered at Auburn, Ala., in less than carload lots. Two years before the same firm had been paid $26 per ton for it delivered at Auburn. It is stated that some of it kept in good condition for more than a year.

Duggar reports seven tests with this by-product. He compared it with corn meal with and without the addition of skim milk, and in a mixed ration of cowpea meal and wheat bran; with a ration of one-half cowpea meal, one-fourth corn meal, and one-fourth rice bran, with the addition of skim milk; and in different proportions with other feeds without skim milk. The pigs used were generally recently weaned and the meal was fed dry.

The following table summarizes the results:

Feeding value of rice polish.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.		
					Grain.		Milk.
					Rice polish lots.	Other lots.	
		Lbs.		*Pounds.*	*Pounds.*	*Lbs.*	*Lbs.*
Corn meal and skim milk	3	90	35	0.86		210	465
Rice polish and skim milk	3	109	35	1.04	170		367
Corn meal	3					670	
Rice polish	3				670		
Corn meal	3	54	28	.64		501	
Rice polish	3	79	28	.94	340		
Corn meal	3	68	56	.40		621	
Rice polish	3	132	56	.79	375		
Corn meal 2, cowpea meal 2, wheat bran 1	3	56	28	.67		370	
Rice polish 2, cowpea meal 2, wheat bran 1	3	66	28	.79	310		
Cowpea meal 2, corn meal 1, rice polish 1, and skim milk	3		35			178	413
Rice polish and skim milk	3		35		193		474
Cowpea meal 2, corn meal 1, rice polish 1	3		35			500	
Corn meal 1, rice polish 1	3		35		420		

In every instance where data were furnished, the pigs on rice polish show more rapid gains than those on corn meal or mixed grain rations. In only two cases did rice polish fail to prove more economical. One of these was the second test with corn meal, where 670 pounds of feed were required by the pigs on both rations. The other was a test with

a mixed ration, where 2 parts cowpea meal, 1 part corn meal, and 1 part rice polish, with skim milk, gave gains at an outlay of 178 pounds grain and 413 pounds skim milk, as compared with 193 pounds grain and 474 pounds skim milk by the ration of rice polish and skim milk.

Duggar summarized the results where rice polish and corn meal were compared directly, and found that an average of 373 pounds of rice polish were required to produce 100 pounds gain, as compared with 474 pounds of corn meal. "At this rate, 78.6 pounds of rice polish were equal to 100 pounds of corn meal, a saving of 21.4 per cent of the grain by the substitution of polish for corn meal."

Gluten meal compared with corn meal.—Pigs that had been fed without success on a potato ration at the Cornell Station[a] were given a "rational ration" of corn meal and skim milk for a week and then they were employed in a test to compare gluten and corn meal. Skim milk was fed, the proportion to meal being about 3 pounds of milk to 1 of meal. Lots I and III received gluten meal and milk, and Lots II and IV corn meal and milk.

Gluten meal was charged at $11.75 per ton, corn meal at $14 per ton, and skim milk at 15 cents per 100 pounds.

The following were the principal results:

Gluten meal compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Dry matter per 100 pounds gain.	Cost per 100 pounds gain.	Dressed weight.	Nutritive ratio.
		Pounds.	*Pounds*		*Pounds.*	*Pounds.*	*Dollars.*	*Per cent.*	
Gluten meal and milk	4	87.25	214	50	1.07	319	2.70	77.40	1:2.7
Corn meal and milk	4	90.5	297.5	50	1.49	264	2.50	80.20	1:5.8
Gluten meal and milk	4	47.5	157.5	50	.79	252	2.40	----------	1:2.7
Corn meal and milk	4	48.5	219	50	1.10	151	1.90	----------	1:5.8

The use of gluten meal in combination with skim milk in this experiment did not give results so satisfactory as where corn meal and milk were fed. Both corn meal lots made better gains and the average of dry matter consumed, and cost per 100 pounds gain were much lower than with the pigs on gluten meal and milk.

Hominy meal compared with corn meal.—In Massachusetts the Hatch Station[b] compared hominy meal and corn meal. The latter is described as consisting of "the hulls, germs, and some of the starch and gluten of the corn ground together. This separation is said to be brought about solely by the aid of machinery. The hard flint part of the corn is the hominy, which is used as a human food."

Seven Chester White grades were fed on a grain and skim-milk ration, 7 to 10 quarts of skim milk being fed daily with a grain allow-

[a] Bul. No. 199. Cornell Univ. Expt. Sta.
[b] Eleventh An. Rpt., Hatch Expt. Sta.

ance of 3 to 6 ounces to each quart of milk, depending on appetite and size. One lot received corn meal and milk, and the other hominy meal and milk. The results are shown in the following table:

Hominy meal compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		Dry matter per 100 pounds gain.
						Grain.	Milk.	Grain.	Milk.	
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	4	56	503	98	1.28	1,022	7,702	203	1,532	321
Hominy meal	3	58	410	98	1.39	766	5,779	187	1,410	306

These figures show hominy meal, as fed in this experiment, to have a feeding value equal to that of corn meal. In this one test corn meal failed to give quite so good results as the hominy meal, showing an average daily gain of 1.28 pounds to 1.39 pounds for hominy meal, and 320 pounds dry matter for 100 pounds gain to 306 pounds dry matter for 100 pounds gain in the case of the hominy meal.

Corn meal compared with cerealine feed.—Two tests were made at the Hatch Station[a] to compare corn meal and cerealine feed. Like hominy meal, cerealine feed "consists also of the hull and a portion of the starch of the corn. It contains rather less of the starch than the hominy meal. It is the by-product resulting from the preparation of the breakfast food known as cerealine flakes. It is very coarse looking and appears very much like unground corn hulls."

In the first test 6 grade Chester White pigs about five weeks old were used. They were fed 6 to 9 quarts of skim milk per head daily, and the grain fed at the start was 3 ounces for each quart of milk; the grain was increased with age and weight. The nutritive ration was 1:3 at the beginning and 1:7 at the close.

In the second test 6 pigs, "a cross between the Poland China and the Chester White," about five weeks old, were fed. Skim milk was fed in connection with the cerealine feed, which was "eaten with seeming relish at all times." The following table shows the results:

Cerealine feed compared with corn meal for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		Dry matter per 100 pounds gain.
						Grain.	Milk.	Grain.	Milk.	
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	3	48	413	106	1.30	731	4,827	177	1.169	260
Cerealine feed	3	45	398	106	1.25	731	4,827	184	1,212	277
Corn meal	3	68	315	78	1.34	680	3,061	216	972	281
Cerealine feed	3	67	293	78	1.25	676	3,061	231	1,041	305

[a] Eleventh An. Rpt., Hatch Expt. Sta.

In these tests cerealine feed showed considerable value as a pig feed, but failed to give as good results, either in rate or economy of gain, as corn meal. Digestion experiments at the Hatch Station with sheep have shown that cerealine feed contains as much digestible matter as corn meal. The station authorities suggest that the coarse nature of cerealine feed lessens its value as a pig feed.

Value of corn hearts.—Duggar[a] fed three lots of 3 pigs each to compare corn hearts with corn meal and cowpea meal. These feeds constituted half the ration, the other half being rice bran. The following table shows the results:

Value of corn hearts.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.	Feed per 100 pounds gain.
		Pounds.		*Pounds.*	*Pounds.*	*Pounds.*
Corn hearts 1; Rice bran 1	3	65	35	0.62	480	738
Cowpea meal 1; Rice bran 1	3	81	35	.77	479	595
Corn meal 1; Rice bran 1	3	98	35	.93	540	550

Analyses at the Alabama Station indicated that the corn hearts used in this experiment contained 8.9 per cent protein and the rice bran 9 per cent protein.

Gluten meal compared with linseed meal for balancing rations.—Patterson, at the Maryland Experiment Station,[b] fed four lots of 5 high-grade Poland China pigs each to compare gluten meal and linseed meal as the nitrogenous components of a ration. Lots I and II received hominy chop three-fifths, linseed meal two-fifths; Lots III and IV received hominy chop three-fifths, King gluten meal two-fifths. Both lots had skim milk in the proportion of 1 pound of milk to 1 of grain. The results were as follows:

Gluten meal compared with linseed meal in a carbonaceous ration.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed per 100 pounds gain.		Cost per 100 pounds gain.
						Grain.	Milk.	
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*
Hominy chop $\frac{3}{5}$, linseed meal $\frac{2}{5}$	5	37	298	60	0.99	242	242	2.71
Hominy chop $\frac{3}{5}$, linseed meal $\frac{2}{5}$	5	36	294	60	.98	242	242	2.70
Average						242	242	2.70
Hominy chop $\frac{3}{5}$, gluten meal $\frac{2}{5}$	5	36	241	60	.80	233	233	2.20
Hominy chop $\frac{3}{5}$, gluten meal $\frac{2}{5}$	5	37	256	60	.85	220	220	2.07
Average						226	226	2.13

[a] Bul. No. 122, Alabama Expt. Sta.

[b] Bul. No. 63.

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This table shows advantages in favor of gluten meal. Both rate and economy of gain favor the corn by-product. The cost of the gluten-meal ration was much less than the one into which linseed meal entered.

COTTON-SEED MEAL.

No feed of the South has so wide a range of interest as cotton-seed meal. It is a concentrated feed of high value for cattle and sheep, and its effect on the fertilizing value of the manure is nearly as great as its effect on the feeding value of the ration.

The influence of cotton-seed meal extends far beyond the States where it is produced, and farmers over the entire country have come to depend upon it to balance their rations and enrich their fields.

Danger of use of cotton-seed meal in pig feeding.—For some reason as yet unexplained this by-product is usually fatal to pigs in from three to ten weeks after feeding has commenced, the mortality being at least 50 per cent. In two tests conducted by the Texas Experiment Station[a] boiled cotton seed gave the least serious results, while soaked raw seed, roasted seed, and raw meal proved more serious. In one test, 10 of the lot of 15 pigs fed cotton seed or cotton-seed meal died. At the Iowa Experiment Station,[b] of 6 pigs that were on a ration of cotton-seed meal, corn-and-cob meal, and buttermilk, 3 died. At the Kansas Experiment Station,[c] 4 young pigs on a ration composed of one-sixth cotton-seed meal and five-sixths corn meal died within forty-six days after feeding commenced. At the Arkansas Station,[d] three lots of 3 pigs each were fed mixed rations, the cotton-seed meal constituting one-third of the grain. All died.

The time intervening between the beginning of feeding cotton seed or cotton-seed meal and the first appearance of trouble varies somewhat. Curtis[e] gives six to eight weeks; Lloyd,[f] in one test, lost the first pig at the end of the fourth week; in another test, deaths began after forty days; Curtiss[g] lost the first pig fifty-one days after feeding commenced. Dinwiddie's[h] first pig died thirty-five days after feeding commenced, and Duggar[i] lost the first pig thirty days after feeding commenced. It therefore appears that there is no very definite period of time that is required for the poison to manifest itself. However, Cottrell[j] states that cotton-seed meal may be fed for three to four weeks before danger is imminent, and Burtis and Malone[k] state that no case has come under their experience "where a pig has died if the cotton-seed meal mixture has not been continued longer than three weeks."

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[a] Bul. No. 21.
[b] Bul. No. 28.
[c] Bul. No. 53.
[d] Bul. No. 76.
[e] Bul. No. 21, Texas Expt. Sta.
[f] Bul. No. 60, Mississippi Expt. Sta.
[g] Bul. No. 28, Iowa Expt. Sta.
[h] Bul. No. 76, Arkansas Expt. Sta.
[i] Bul. No. 122, Alabama Expt. Sta.
[j] Bul. No. 95, Kansas Expt. Sta.
[k] An. Rpt. 1901-02, Oklahoma Expt. Sta.

Symptoms of poisoning.—Poisoning is manifested in a peculiar manner. In many cases pigs that are apparently well in the evening are found dead in the morning, and often the most careful watching fails to show any indications of indisposition. Where symptoms are present those most characteristic seem to be disorder of respiration, which is manifested by quickened breathing, coughing, or hiccough. Failing appetite usually calls the attention of the feeder to the approach of danger. Seldom more than two days intervene between the first symptom and death. Francis[a] gives the following symptoms of the trouble with the Texas pigs:

The attack was sudden, as a rule; in fact, in a majority of cases an animal was found dead that had been apparently well twelve hours before. In those cases which we were fortunate enough to witness the symptoms were those of a sudden contraction of the diaphragm, producing a sound similar to hiccough in man. The animal stood with head near the ground, the flanks tucked up, the ears hanging pendulous, and the tail straight and limp. Some would lie flat on the belly—never on the side—while others would assume a sitting-up posture with the fore legs well apart. In several cases there was a marked elevation of temperature, the thermometer registering 106° F. per rectum. The circulation seemed very weak and rapid. * * * As a rule they were dead in an hour. * * * The gaspings became more and more frequent and violent, and after a few struggles the animal was dead. In the last moments great quantities of foam or froth would come from the nose or mouth.

The symptoms observed by Dinwiddie[b] are described as follows:

The disease in all cases was of a type which might be described as acute. In everal instances the animals were said to be "off feed" for one or two days efore other symptoms were observed. Every animal which exhibited any sympoms at all died within twenty-four hours. It would remain by itself, standing, isinclined to move, breathing with extreme rapidity and jerking or "thumping" n the flanks, and before death frothing at the mouth and nostrils. Fever was bsent or but slight; eyes dull and sometimes bloodshot. Coughing occasionally ccurred.

Pathological features.—Francis[a] states: "On postmortem examinaion the digestive organs appeared normal throughout. The other bdominal organs appeared normal. The respiratory organs were ull of foam. The lungs themselves were bright red and very much ongested and doughy." Mayo[c] pronounced the death of the Kansas igs to be due in all cases to "congestion and inflammation of the ntestines, lungs, and heart;" but Niles[d] could find no assignable use of death in the case of the Iowa pigs.

Dinwiddie,[b] in the Arkansas experiments, made postmortem examinations of 8 of the 9 pigs which died, and found a very constant conition of disorder. He says, in describing the first examination, the escription of which applied to all cases:

The body presented no external changes. Subcutaneous tissue showed blood travasations in streaks and points. Blood engorgement of lymph nodes of neck

[a] Bul. No. 21, Texas Expt. Sta.
[b] Bul. No. 76, Arkansas Expt. Sta.
[c] Bul. No. 53, Kansas Expt. Sta.
[d] Bul. No. 28, Iowa Expt. Sta.

and jaws. Respiratory and buccal mucous membrane dusky red. Pleural cavities contain a large quantity of yellow, cloudy fluid, compressing the lungs to less than half their normal bulk. In the pericardial sac there is a similar dropsical effusion, part of which has formed into a soft, yellowish-white clot. No evident pleuritis. Lung dark red, congested, and collapsed. Cavities of heart contain dark, soft blood clots; slight petechial extravasations on the epicardium. No obvious peritoneal effusion. Liver is dark in color, friable, and deeply blood-engorged, the lobular boundaries on section being unusually prominent, with dark-red depressed centers. Kidneys on section appear congested throughout, capsule nonadherent. * * *

The stomach and intestines often showed abnormal features. The small intestine (jejunum) frequently showed hyperemic patches on both the serous and mucous surfaces, and the large intestine and stomach in several cases contained considerable quantities of gravel. The urine was slightly albuminous in two cases. In one instance, where the brain was dissected, there was engorgement of the veins and sinuses of the dura mater, which extended "backward into the vessels of the neck."

The histological examination is described as follows:

Sections of the liver tissue reveal an intense congestion of the portal system, the intralobular capillaries especially being enormously engorged throughout and the liver cells compressed and shrunken. There is, however, no marked degeneration, and the nuclei take the stain in the normal manner. Sections of the kidney exhibit a similar capillary engorgement, though less intense. The glomerular tufts are compressed by edematous effusion into their capsules. A degenerative process in the cells of the urinary tubules or other marked pathologic changes were not demonstrated. In the spleen no distinct pathologic changes are found. Lung sections show a marked congestion of the capillary vessels, with edematous effusion and occasional blood extravasations, but without cellular proliferation or infiltration. There is no evidence of pneumonia or pleurisy.

Treatment.—As a rule, hogs suffering from the effects of cotton-seed poisoning, if taken from the cotton-seed ration and placed on rich green pasture, become apparently well in a week.[a] A similar result follows when they are simply deprived of the cotton-seed meal of the ration and given an ordinary grain ration. However, Burtis[b] reports a case where a pig died during the winter after a week's feeding on a straight corn diet that followed four weeks' feeding on a ration of one-fifth cotton-seed meal and four-fifths corn meal; and Dinwiddie and Duggar had similar experiences. In some cases pigs may pass through a season of cotton-seed meal feeding and thereafter be indifferent to it. Curtis[c] found that if a pig lived thirty days after the first appearance of trouble it could be regarded as immune from the effects of cotton seed, but the experience of others seems to contradict this. Dinwiddie[d] gives two months as the time

[a] Bul. No. 60, Mississippi Expt. Sta.; An. Rpts., 1900-01 and 1901-02, Oklahoma Expt. Sta.

[b] An. Rpt. 1901-02, Oklahoma Expt. Sta.

[c] Bul. No. 21, Texas Expt. Sta [d] Bul. No. 76, Arkansas Expt. Sta.

required for a hog to be on cotton-seed meal before it can be regarded as immune.

The cause of poisoning not known.—The poisonous agent of cotton seed has not yet been determined. So far chemical and bacteriological examinations have revealed nothing to which can be attributed its dangerous character. The injurious action has been variously attributed to the lint on the seed, the large fat content, the highly nitrogenous composition, the sharpness of the hulls, the presence of a toxin, supposititious chemical or bacteriological changes in the meal, formation of poisonous crystals by metabolism, etc. Up to a certain period the amount of cotton seed or cotton-seed meal fed does not seem to have any influence on the health of the pigs, but the evidence on the subject is so meager that one is not justified in drawing conclusions as to the amount of meal that can be fed safely. Curtiss[a] inclines to the toxin theory; he found the amount which proved fatal in his investigation to be from 27 to 33 pounds of cotton-seed meal. Dinwiddie[b] holds that the belief that there is a toxic principle in the seeds of the cotton plant is the most reasonable one, and one that has not been disproved. The action seems to be more virulent with young than with older animals, which is characteristic of poisons. He points out that the amount fed to pigs is much larger in proportion to their body weight than that fed to cattle and suggests this as a reason for the supposed greater immunity of cattle. With a 1,000 pound steer, 4 pounds of cotton-seed meal is an amount equal to 0.4 per cent of the body weight. In the case of the pigs in the Arkansas experiments the proportion was about 1.5 per cent of the body weight at the beginning of feeding. The amount of cotton-seed meal eaten per head was 23, 25, and 45 pounds, respectively, in the three experiments at that station. Dinwiddie[c] calls attention to the fact that other animals are susceptible to cotton-seed poisoning and states that guinea pigs, to which he fed small quantities of cotton-seed meal along with bran, died in from two to three weeks. He also admits the possibility of ptomaine poisoning.

At the Alabama station two of Duggar's[c] experiments resulted fatally. In the first experiment the smaller pigs were the first to die. They averaged about 64 pounds, and 12.20 pounds of cotton-seed meal were eaten by each before death ensued. This was 0.25 pound daily per head, or 0.4 pound daily per 100 pounds live weight for forty days, and a total of 18.90 pounds per 100 pounds average live weight. Larger pigs in this experiment, averaging a little over 70 pounds, died when 16.60 pounds of cotton-seed meal had been fed per head. These pigs were fed 0.41 pound per head daily, or 0.53 pound

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[a] Bul. No. 28, Iowa Expt. Sta.
[b] Bul. No. 122, Alabama Expt. Sta.
[c] Bul. No. 76, Arkansas Expt. Sta.

per 100 pounds live weight daily, for forty-three days; the total amount of cotton-seed meal fed was 21.60 per cent of the average live weight. In the second fatal experiment one of the pigs died "after having appeared gaunt and weak for two days." This pig averaged about 60 pounds in weight and up to the time of death had been fed 5.4 pounds of cotton-seed meal. This was a total of 9.2 pounds per 100 pounds live weight. The pig had not had more than 0.25 pound cotton-seed meal daily per 100 pounds live weight. The other pig in the same lot showed an unthrifty condition and the ration was changed. (See the Kansas experience on page 122, where a similarly small amount of cotton-seed meal produced fatal results.) The ration in both experiments was, cotton-seed meal one-fifth, corn meal four-fifths.

In another test with a ration of corn meal three-fourths, cotton-seed meal one-fourth, the pigs were noticed to be out of condition toward the thirty-fifth day, but no deaths occurred. They averaged about 118 pounds in weight, and the amount of cotton-seed meal which made them sick was 25.5 pounds. This was 21.4 pounds per 100 pounds live weight, or 0.61 pound daily per 100 pounds live weight.

The causes of death are regarded by Dinwiddie[a] as being both essential and contributory, the essential cause being the toxic principle supposed to be present. He describes the immediate cause of death as follows:

> In all our cases the immediate cause of death was obviously asphyxia, due to pressure on the lungs by the dropsical effusion into the pleural cavities. In its final manifestations the disease was an acute dropsy of the pleural and pericardial sacs. The congestion of the abdominal organs, and especially of the portal system, can be attributed to obstructed circulation through the collapsed lungs damming the blood back in the venous system, and hence a process secondary to the pleuritic effusion. That this portal engorgement was secondary to the pleural effusion, I infer from the absence of degenerative or other changes in the liver which could account for it and from absence of any marked peritoneal effusion. Ascites would be the first result of such extreme portal congestion if it were primary. All of these conditions, however, are necessarily the result of some fundamental cause, the nature of which is yet to be discovered. An acute hydrothorax and hydrops pericardii, unaccompanied by ascites and without any antecedent pleuritis, is a condition rarely met with in human pathology. Non-inflammatory dropsical effusion may be due to mechanical obstruction, cardiac disease, degenerative changes in the kidney or liver, or to physical or chemical changes in the blood itself. Neither of the first three causes appears to be in operation here. Further researches will probably show some grave alteration in the composition of the blood as the primary effect of acute cotton-seed meal poisoning. In hogs, at least, nervous derangements are not manifested, so far as I have seen.

Points that may in time lead to the discovery of the trouble are that old meal seems to be more fatal than fresh, that cotton-seed meal is more fatal than cotton seed in any condition, and that the poisonous agent is not in the oil, but seems to be entirely left in the cake

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[a] Bul. No. 76, Arkansas Expt. Sta.

when the oil is expressed. It is also well known throughout the South that decomposed cotton seed has little, if any, dangerous character, and it has been pretty clearly established by the studies of Curtiss[a] and by the experience of practical feeders that the meal is so changed by the processes of digestion that hogs following steers which are being fed a heavy cotton-seed meal ration are not injured by the droppings.

Feeding value.—Disregarding, for the moment, the fatal effects of this product, let us consider its feeding value. The results from feeding either the whole grain or the meal have not been uniform, and have given rise to three opinions regarding its value as a pig feed—(1) that it is both worthless and dangerous; (2) that it is only fairly valuable and hardly worth the risk of feeding, and (3) that it is extremely valuable if means can be devised to feed it without fatal results.

The Kentucky Experiment Station[b] fed a ration of 1 part cotton-seed meal, 1 part wheat bran, and 2 parts corn-and-cob meal for twenty-eight days, when ship stuff replaced the cotton-seed meal, because the pigs refused it, whether fed wet or dry. No fatalities were reported, but the gains were unsatisfactory and the station came to the conclusion that, in Kentucky, "cotton-seed meal could not be fed profitably to hogs, whether for growth or fat."

Curtis[c] expresses himself in a similar tone, that, "After two years successive tests in feeding cotton seed and cotton-seed meal to hogs with a definite aim in view, and after practical attempts to use these products in a similar manner for the past ten years, we do not hesitate to express our candid opinion that there is no profit whatever in feeding cotton seed in any form or cotton-seed meal to hogs of any age; * * * that it is practically impossible to prepare cotton seed or cotton-seed meal in any manner so that hogs will eat it greedily."

Lloyd's[d] opinion, from his experience at the Mississippi Station, is somewhat similar. He had losses from raw cotton-seed meal, but none from those getting cooked seed, although these pigs became very sick and refused to eat. His gains were "neither satisfactory nor profitable." With one bunch of pigs the average daily gain was about 1 pound for the first two weeks, after which the gains were small, although the pigs did not lose their appetite and continued to eat with relish. The after effects of feeding in this case were detrimental, as the pigs never got into good condition.

At the North Carolina Station, Emery[e] fed an 88-pound pig for sixty-one consecutive days on a cotton-seed meal ration, the amount of cotton-seed meal varying from one-fourth pound daily at the beginning to 2 pounds daily at the close. Skim milk was fed during

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[a] Bul. No. 28, Iowa Expt. Sta.
[b] Bul. No. 19.
[c] Bul. No. 21, Texas Expt. Sta.
[d] Bul. No. 60.
[e] Bul. No. 109.

the first three weeks and green feed during the first six weeks. Two pounds of cotton-seed meal daily made the pig sick, and for twenty-two days the meal was dropped from the ration. Then the feed was made one-fourth cotton-seed meal, three-fourths wheat bran, with 12 pounds skim milk daily for ten days, after which corn meal was substituted for the cotton-seed meal. The feeding was unprofitable, but the pig did not die.

Among the instances where feeding was fairly profitable, the results at the New York (State) Station[a] may be noted. The intention was not to note the effects of cotton-seed meal feeding. Cotton-seed meal in amounts varying from one-thirteenth to three-tenths of the entire ration was fed, with good results, covering periods of from fifty-six to one hundred and thirty-nine days. Two pigs in a lot fed on wet feed were troubled with indigestion, and after the close of the trial one of them died from "congestion of the liver, following indigestion." This may have been cotton-seed meal poisoning. The pigs were on a ration in which there was three-tenths pound daily for sixty-three days.

Cary's[b] results in Alabama are remarkable because of the large quantities of cotton seed fed. He conducted three experiments in which cotton seed or cotton-seed meal were fed to 13 pigs. From 1½ to 4½ pounds of crushed cotton seed were fed per head daily. In two instances cotton-seed meal was fed, but in small amounts (three-tenths pound daily in one case and three-fifths pound in the other). The pigs receiving cotton-seed meal did not thrive, losing appetite; one of them received bran, the other corn meal in addition to the cotton-seed meal, and both had green feed. When they were taken from cotton-seed meal and placed on corn and pasture they recovered rapidly.

In the first test the pigs on crushed cotton seed made fairly good gains. They had some grain in addition, and all received green or succulent feed. In the second test 3 pigs were fed rations of corn meal and crushed cotton seed or ground cowpeas and crushed cotton seed. The rations were heavy—6 pounds when corn meal was fed and 6½ pounds when cowpeas were fed; the amount of cotton seed was more than half the ration. Fair gains were made and the after effect does not seem to have been serious, as the pigs did well when placed on pasture and fed corn. One pig in this lot had crushed cotton seed alone, being fed 4½ pounds daily. He lost in weight, but gained in size of frame. When turned on pasture and given corn he did well. Another pig that had 3½ pounds crushed cotton seed and 3½ pounds green rye daily lost 28 pounds in twenty-eight days. After the rye was discontinued the pig failed to thrive, but recuperated rapidly on pasture with corn.

In three cases where 3 pounds of crushed cotton seed were fed daily, with ground cowpeas and green rye or corn meal and green rye,

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[a] Eleventh and Twelfth An. Rpts. [b] Bul. No. 68, Alabama Expt. Sta.

nominal gains were made. No disastrous effects followed when green feed was discontinued; subsequent treatment on pasture and corn gave good gains.

In a third test 2 pigs were fed for forty-nine days on a daily ration of 6 pounds of separator milk and 3½ pounds crushed cotton seed, then for fifty days on 6 pounds of whole milk and 3½ pounds crushed cotton seed. Their appetites failed twice, but they gained slightly in weight.

The length of time that cotton seed or cotton-seed meal was fed in these experiments was one hundred and five days in the first, ninety-one days in the second, and one hundred and nine days in the third. Although the pigs were occasionally off feed there were no fatalities.

Duggar's[a] experiments did not show very favorable results for cotton-seed meal as part of the pig's ration. In no case did the pigs so fed make so great an average daily gain as 1 pound, and the gains were usually expensive, whether the grain was fed alone or with green feed. Rations of corn meal only gave better results. One lot of 2 pigs, averaging 68 pounds, fed a ration of cotton-seed meal one-fifth, corn meal four-fifths, and grazed on sorghum, made an average daily gain of 0.53 pound for thirty-four days, at an outlay of 380 pounds of grain for 100 pounds gain. Another, averaging 68 pounds, on the same grain ration, but grazing peanuts, made an average daily gain for thirty-eight days of 0.94 pound, requiring 185 pounds grain for 100 pounds gain. Another lot made an average daily gain of 0.8 pound for twenty-eight days on a ration of cotton-seed meal one-fourth and corn meal three-fourths, requiring 384 pounds grain for 100 pounds gain, while a lot on corn meal only in the same test made an average daily gain of 1.1 pounds, but required 531 pounds grain for 100 pounds gain. Duggar found corn meal alone a more palatable ration than one to which cotton-seed meal had been added, and had difficulty in inducing pigs to eat a full allowance of a cotton-seed meal ration.

The Kentucky, Wisconsin, Iowa, Kansas, and Oklahoma experiment stations have published results that show cotton-seed meal to have considerable feeding value for pigs.

In Kentucky May[b] fed cotton-seed meal at intervals of one week as part of the ration to 20 grade Berkshire pigs during a three weeks' finishing period with very good results.

At the Wisconsin Station,[c] Henry fed two lots of 5 pigs each for thirty-five days on a ration of which one-half pound daily was cotton-seed meal. The feeding was alternated, one lot receiving oil meal while the other had cotton-seed meal. The rest of the grain ration was a mixture of equal parts of wheat shorts and corn meal. Skim milk and whey were fed, and the feeding was done in the fall and

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[a] Bul. No. 122, Alabama Expt. Sta.

[b] Bul. No. 101, Kentucky Expt. Sta.

[c] Eleventh An. Rpt.

winter. The pigs were never sick nor off feed, and made their gains economically. The tabulation of results shows that while on cotton-seed meal the pigs required 5 per cent less feed than while on oil meal.

At the Iowa Experiment Station, Curtiss[a] fed two lots of 3 Poland China pigs each on a ration of corn-and-cob meal, cotton-seed meal, and buttermilk. One lot received one-half pound cotton-seed meal per head daily and the other 1 pound per head daily. The grain fed was soaked for twelve hours before feeding. Salt and ashes were also given. Everything went well until the sixth week, when the droppings of the pigs on the heavy ration became dark in color and somewhat hard. However, the appetite was not affected. The first pig died fifty-one days after feeding commenced, and a second went the day following. They had been on the heavy ration, but showed no signs of sickness, and their gains had been steady. Sixty-three days after the start a pig in the lot receiving one-half pound of cottonseed meal per head daily died, but not without symptoms of trouble. For a day or two before death he had shown a "failing appetite and quickened breathing." The rest of the pigs in this lot showed the same symptoms, but survived, although their gains were light. The Station veterinarian could find no assignable cause of death.

In this experiment the fatal quality of cotton-seed meal seemed to depend, to a certain extent, on the quantity fed. The first pigs to die were those in the lots receiving the heavier ration of cotton-seed meal. These pigs also made the better gains.

The Kansas Station[b] fed 4 small pigs a ration of one-sixth cotton-seed meal and five-sixths corn meal. The meal was stirred in water at feeding time. It was not relished at first, but when it was once eaten rapid gains were made. The first pig died twenty-three days after the feeding began, and "could not have eaten more than 5 pounds of cotton-seed meal altogether," a fact which seems to lessen the weight of the theory that the quantity eaten has an influence on the fatal property of the feed. This pig weighed about 18 pounds at the time of its death. The last pig died on the forty-sixth day of the experiment. (See Duggar's experiments, pp. 117, 118.)

Two sows weighing, respectively, 135 and 308 pounds were put on a ration of one-fourth cotton-seed meal and three-fourths corn meal for forty-five days; they gained 89 pounds each without signs of poisoning.

In a second test, 6 pigs that had been stunted by exclusive corn meal or ground wheat feeding were divided into two lots of 3 each and put on rations composed of one-fourth cotton-seed meal and three-fourths corn meal for one lot, and equal parts of these meals for the other lot. The change of condition is described as "magical" and

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[a] Bul. No. 28.

[b] Bul. No. 53.

immediate; the pigs began to gain in weight at once, and those receiving the greater amount of cotton-seed meal made the larger gains. No other feed was given. The first pig died on the forty-fifth day of the experiment, the second on the forty-eighth day, the third on the fifty-third day, and the fourth on the fifty-sixth day from the beginning of the cotton-seed meal feeding. Two pigs were left in each lot; they were placed on green oats and then thrived nicely.

A later bulletin[a] from the Kansas Station mentions a lot of pigs that had done poorly in another experiment; they were fed cotton-seed meal, and were "ready for market, well finished, in twenty-two days." At the Kansas Station cotton-seed meal is very highly regarded to put pigs in high condition, if fed for a short time in small quantities. The beginning ration is one-fourth pound cotton-seed meal to each 1,000 pounds live weight per day, which is increased in ten days to make the amount 3 pounds per 1,000 pounds live weight.[b] The meal is mixed with the rest of the grain.

The Kansas and Iowa results show that a cotton-seed meal ration is valuable if the cotton-seed meal is used in a moderate amount and for a limited time. The proportions of cotton-seed meal used in the Iowa test were about one-eighteenth and one-ninth of the total grain rations at the start and about one-tenth and one-fifth at the close. Up to the time the pigs began to die the gains of those on the heavier cotton-seed meal ration were the larger and more economical (1.4 pounds average daily gain and 343 pounds meal and 250 pounds milk per 100 pounds gain). The lighter ration was about equal in results to one of corn-and-cob meal, gluten meal, and buttermilk, that stood second to the heavy cotton-seed meal ration. The two lots returned in pounds of gain per 100 pounds of dry matter in the feed (before deaths began) 31.1 pounds and 26.4 pounds, respectively, for the pigs on the heavy and the light rations. In the Kansas tests the gains before deaths commenced were also very economical; they varied in cost from considerably less than 300 pounds grain per 100 pounds gain in the case of the pigs that had been previously on the single-grain rations to 350 pounds grain per 100 pounds gain in the case of the sows.

Pigs following steers on cotton-seed meal.—Evidence of the dangerous properties of cotton-seed meal for pigs, when they are following steers whose ration is made up wholly or in part of cotton-seed meal, is conflicting. In the Iowa test[c] a lot of 3 pigs followed steers for seventeen weeks that were receiving from 4 to 7 pounds of cotton-seed meal daily. They had very little feed except what they picked up behind the steers, yet there were no noticeable injurious effects.

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[a] Bul. No. 95.

[b] This is about the ration furnished dairy cows in milk.

[c] Bul. No. 28, Iowa Expt. Sta.

The Kansas Station[a] states that the meal used in their early experiments was shipped in from Texas during the previous winter by a local feeder, to be fed to steers. He turned about 40 hogs after them, and all died in the course of six or seven weeks. Considerable evidence that pigs may not suffer after steers that are fed on cotton-seed meal has recently been presented in the columns of the agricultural press.

THE OKLAHOMA EXPERIMENTS.

The Oklahoma Station has made an extensive study of the possibility of feeding this by-product so that good returns may be obtained with little or no danger from poisoning. The conditions under which it has been found that cotton-seed meal may generally be fed safely are (1) where pigs have access to range and plenty of green pasture, and (2) where periods of cotton-seed meal feeding of three to four weeks' duration without pasture are alternated with a period on pasture or on a ration from which the cotton-seed meal has been omitted.

Following up this system the Oklahoma Station has conducted three experiments. In the first trial, in 1900, the alternating method was tried with 17 thrifty shoats of various sizes.[b] They were put on a ration composed of one-fifth cotton-seed meal and four-fifths Kafir-corn meal and had the run of a large paddock, where they got a little green stuff. The trial began March 22. For twenty-seven days the cotton-seed meal ration was fed; then for fourteen days Kafir-corn meal alone, next fourteen days on one-fifth cotton-seed meal, and four-fifths Kafir-corn meal, then seven days without the cotton-seed meal, closing with five days on the original ration. "None of the pigs had died, and all made very fair gains on a moderate amount of grain." At the close of this trial part of the pigs were sold and the rest continued on the cotton-seed meal ration, with which the trial closed (one-fifth cotton-seed meal and four-fifths Kafir-corn meal). They were fed on this ration without change until July 14 with the loss of 1 pig only.

In the second trial of the same year 16 stunted shoats, about a year old and averaging 79 pounds were used. For twenty-six days from April 12, they were hurdled on wheat and fed a light ration of one-fifth cotton-seed meal and four-fifths Kafir-corn meal. There was no ill effect from the grain ration. The gains averaged 0.96 pound per head daily and were made economically. On May 8 the pigs were taken from the wheat and fed the same grain ration in a lot for twenty-one days with no serious results, making an average daily gain of 1.71 pounds at the expense of 307 pounds of grain for 100 pounds gain. Five of the largest were sold after forty-seven days continuous feeding on a cotton-seed meal ration.

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[a] Bul. No. 53.

[b] An. Rpt., 1900–01.

The 11 pigs remaining were then given range and green feed and the same grain ration continued. The gains made were satisfactory. There were no losses, and they were sold on July 14, after ninety-three days' continuous feeding on a cotton-seed meal ration.

In 1901, 16 uniform Poland China shoats, farrowed late in the previous fall, were used.[a] They were about 11 weeks old at the beginning of the experiment and averaged about 47 pounds in weight. The experiment began January 11. The pigs were divided into four lots of 4 each. Each lot was given an open pen 9 by 24 feet, and had a space 8 by 8 feet in an inclosed piggery. Cob charcoal, wood ashes, and salt were always accessible; water only was given to drink, and the grain was mixed with water into the form of a thick slop just before feeding. From July 14 to April 1, 2 pounds of sugar beets were allowed each pig daily. The pigs were fed as follows: Lot I received corn meal only to April 5, then a mixture of one-fifth cotton-seed meal and four-fifths corn meal for four weeks, closing with two weeks on corn meal; Lot II received one-third corn meal and two-thirds wheat middlings; Lot III received one-fifth cotton-seed meal and four-fifths corn meal. Lot IV received one-fifth cotton-seed meal and four-fifths corn meal for four weeks, then corn meal for two weeks, next the cotton-seed meal mixture for four weeks, then back to corn meal only for two weeks, and alternating in this manner until the experiment closed.

The only signs of lack of appetite were in Lot I, where exclusive corn-meal feeding proved rather severe for such young pigs, and in Lot III, where a dullness of appetite was noticed for about two weeks. This was only temporary. One pig in Lot IV died on February 15, one week after it had been taken from the cotton-seed meal ration and placed on corn meal, and 2 pigs in Lot III died on February 20, after they had been on a cotton-seed meal ration continuously for forty days.[b] "No further losses occurred, * * * and the pigs thrived and made good gains." One pig in Lot IV showed symptons of sickness, but recovered.

After April 5, Lot I was given the same management and feed as Lot IV, but there were no injurious results. On the contrary, their gains increased. This was also noticed with Lot IV. During the periods that the hogs were on a straight corn-meal ration, except during the closing period, when their greater maturity enabled them to make use of a more carbonaceous ration, the gains were light and expensive, but when the cotton-seed mixture was resumed the gains were large and economical, disregarding the effect of loss by death.

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[a] An. Rpt., 1901-02.

[b] Dinwiddie had a similar experience. See Bul. No. 76, p. 147, Arkansas Expt. Sta.

The following table shows the results of the one hundred and twenty-six days feeding for the pigs that survived:

Feeding pigs on cotton-seed meal rations.

Ration.	Number of pigs.	Average weight at beginning, January 11.	Average weight at close, May 17.	Average gain.	Average daily gain.	Average amount grain eaten.	Grain per 100 pounds gain.	Cost of grain per 100 pounds gain.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*
Lot I:								
Corn meal	4	46	125	78	0.62	368	470	2.61
Lot II:								
Corn meal $\frac{1}{8}$; Wheat middling $\frac{7}{8}$	4	46	191	146	1.15	539	370	2.87
Lot III:								
Cotton-seed meal $\frac{1}{5}$; Corn meal $\frac{4}{5}$	2	47	182	135	1.07	483	357	2.24
Lot IV:								
Alternate rations	3	44	178	134	1.06	493	368	2.14

Burtis and Malone suggest that had the cotton-seed meal lots been running on green pasture from the beginning of the experiment no losses would have occurred. They also suggest the probability that a ration of one-tenth to one-fifth cotton-seed meal may be fed for an indefinite time if pigs have the run of green pasture.

THE ARKANSAS EXPERIMENTS.

In addition to throwing light on the pathological features of cotton-seed poisoning, Dinwiddie[a] has corroborated the results of those stations, which have shown that, when properly fed, cotton-seed meal is a valuable pig feed, if losses can be avoided. In the experiments in which all the pigs died, Lot I received a ration of cotton-seed meal 1 part and corn chops 3 parts; Lot II received cotton-seed meal 1 part, and corn meal 3 parts, with roots; Lot III received cotton-seed meal 1 part and wheat bran 3 parts, and Lot IV received bran 1 part and corn chops 3 parts. There were three pigs in each pen, and feeding began January 1, 1902. The pigs were confined in pens with an open shed for shelter, were watered and fed twice daily, and had a mixture of hard-wood ashes and salt supplied constantly. The results are tabulated as follows:

Feeding pigs on cotton-seed meal rations.

Lot.	Number of days until first death.	Eaten per head.	Eaten daily per head.	Eaten daily to initial weight.	Initial weight.	Daily gain per head	Daily gain to initial weight.
		Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*	*Per cent.*
Lot I	35	23	.68	1.6	41	0.9	2.2
Lot II	40	25	.64	1.5	42	1	2.4
Lot III	61	45	.80	1.6	48	1	2.1
Lot IV					47	.9	1.9

[a] Bul. No. 76, Arkansas Expt. Sta.

Dinwiddie points out particularly that a corn-meal and cotton-seed-meal ration, which one would naturally select as giving the proper proportions between nitrogenous and carbohydrate constituents, proved the most fatal in his experiments, and that the bran and cotton-seed meal ration, the most nitrogenous of the three, required the most time for the dangerous property to assert itself. Contrary to what one would expect from the Oklahoma results, roots did not have so good an effect as the wheat bran.

The pigs received from 0.64 to 0.8 pound of cotton seed per head daily, which was from 1.5 to 1.6 per cent of their initial body weight. The first death occurred in the case of the pigs on corn and cotton-seed meal thirty-five days after the feeding commenced, an average of 23 pounds cotton-seed meal being eaten per head. In the case of the pigs fed corn, cotton-seed meal, and roots, the first death was forty days after the beginning, an average per head of 25 pounds of cotton-seed meal being eaten. The first death in the case of the pigs on bran and cotton-seed meal occurred sixty-one days after the beginning, 45 pounds of cotton-seed meal being eaten per head. Up to the time of death the gains of the pigs on cotton-seed meal were as good or better than those of the pigs on corn chops and bran (Lot IV).

Following the experiment in which all the pigs on cotton-seed meal died, Dinwiddie[a] fed 4 native pigs, averaging about 50 pounds in weight, on various rations, cotton-seed meal being a prominent factor, constituting one-fourth of the ration. Turnips were fed for eighty days, after which rye, oats, and alfalfa were given for two months. The pigs were fed from February 26 to November 6, 1902. Only 1 received cotton-seed meal throughout the experiment, and for a small part of the time none was given to it. The other pigs received rations of equal parts of bran and corn meal or ear corn after being taken from the cotton-seed-meal ration.

Dinwiddie presents the following tabulation of the results of this experiment:

Feeding pigs on cotton-seed meal rations.

Designation of pig.	Number of days fed cotton-seed meal.	Weight of cotton-seed meal eaten.	Weight of cotton-seed meal eaten daily in first period (80 days).	Daily consumption of cotton-seed meal to initial weight.	Weight of cotton-seed meal eaten daily in second period (59 days).	Weight of cotton-seed meal eaten daily for remainder of test.
		Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*
[illegible]	139	80	0.58	1.4	[a] 0.55	
[illegible]	248	242	.58	1.4	.55	[b] 1.5
[illegible]	198	137	.58	1.4	.55	[c] 1
[illegible]	198	137	.58	1.4	.55	[c] 1

[a] Decrease probably due to a larger supply of green feed.
[b] One hundred days. (Cotton-seed meal 1, corn meal 3.)
[c] Fifty-nine days.

A third test[a] was made in which rations of cotton-seed meal 1 part nd bran 3 parts and cotton-seed meal 1 part and wheat chops 3 parts

[a] Bul. No. 76, Arkansas Expt. Sta.

were fed. The former ration was fed for ninety-five days to 6 pigs, which averaged about 50 pounds in weight. The latter was given for ninety-nine days to 4 Tamworth pigs, averaging about 50 pounds in weight. The following table shows the results:

Feeding pigs on cotton-seed-meal rations.

Ration.	Number of pigs.	Time fed cotton-seed meal.	Average amount cotton-seed meal eaten.	Average amount cotton-seed meal eaten during first month.	Cotton-seed meal to estimated initial body weight.	Average amount cotton-seed meal eaten daily after first month.	Cotton-seed meal eaten daily during test.
		Days.	*Pounds.*	*Pounds.*	*Per cent.*	*Pounds.*	*Pounds.*
Cotton-seed meal 1, bran 3	6	95	54	0.4	0.8	0.6	0.5
Cotton-seed meal 1, wheat chops 3	4	99	57	[a].4	18	[b].7	.5

[a] First half of period. [b] Last half of period.

There were no losses from these rations, and the pigs made small gains.

Effect of cotton-seed meal on pregnant sows.—Dinwiddie[a] fed a native sow carrying her third litter on a ration of cotton-seed meal 1 part and bran 3 parts for eighty days before farrowing. She ate a total amount of 112 pounds of cotton-seed meal, which was 1.39 pounds daily and 0.8 per cent of the estimated initial body weight. The ration agreed with her and there appeared to be no harmful effects on the fetal litter, it being farrowed safely, with no stillbirths.

Effect of crude cotton oil.—Dinwiddie[a] fed 3 pigs on a ration of corn meal 1 part, wheat bran 2 parts, and crude cotton oil 0.1 to 0.4 part. The amount of cotton oil fed (estimating the fat content of cotton-seed meal at 14 per cent) was equivalent to that contained in from 0.25 to 1.8 pounds of cotton-seed meal, the smaller amount having proved fatal in the Arkansas results, already discussed. These pigs were on the cotton-oil ration one hundred and forty-four days. The amount of oil fed for the entire time to each pig was 21 pounds, equivalent to 150 pounds of cotton-seed meal. The average daily amount of oil consumed varied from 0.06 pound (meal equivalent, 0.4 pound) to 0.24 pound (meal equivalent, 1.6 pounds). The average daily amount of oil fed for the entire test was 0.14 pound (meal equivalent, 1 pound). The pigs made an average daily gain of 0.6 pound, and suffered no serious effects from the oil.

Use of cotton-seed meal in the feed lot.—The use of cotton-seed meal in the feed lot must be very carefully guarded, especially until the conditions under which it may be used without danger and the circumstances which govern the demonstration of its poisonous properties are more thoroughly understood. The feeding of the cotton-seed meal which the South produces is one of the greatest problems of agri-

[a] Bul. No. 76, Arkansas Expt. Sta.

culture in that section yet to be solved satisfactorily. It is not difficult to appreciate what may be gained if some of this by-product, which has such high feeding and fertilizing value, and which is exported in such enormous quantities, can be converted into pork products, which are now largely imported from other States.

PACKING-HOUSE PRODUCTS.

The frugality of the modern meat packer has become almost proverbial. Less than twenty years ago the disposal of the offal of slaughtering was a problem, but at present there is very little waste, and the packer has actually come to regard the by-products as the principal source of profit in his business. The preparation of these by-products for use as animal feed is one of the later developments of this branch of the industry. Fertilizers have long been prominent in the sales, the material that enters into their composition being meat scraps, blood, bone, hair, intestinal contents, etc. The use of tankage, a by-product that has had its sale entirely as a fertilizer, is growing among pig feeders, and has been studied by Plumb and Van Norman at the Indiana Station, and by Kennedy and Marshall at the Iowa Station. Beef meal is also a packing-house product, whose feeding value was studied along with that of tankage in the Iowa experiment.

Character of packing-house by-products.—Plumb and Van Norman[a] state that tankage may contain scraps of meat, intestines, and their contents, hair, etc. It is classed as *concentrated* and *crushed* tankage. Concentrated tankage is not used for animal food. Crushed tankage is said to be of several grades, being graded according to the ammonia and phosphoric-acid content, although it is probable that the tankage graded as No. 1 is free from the contents of intestines.

Kennedy and Marshall[b] used two brands of tankage made by Chicago packers. One of these is described as follows:

> Digester tankage is made from meat scraps, fat trimmings, and scrap bones. These are taken up as fast as taken from the animals and put into a large steel tank and cooked under a live steam pressure of 40 pounds to the square inch, which cooks out the tallow. After the steam is turned off it is allowed to settle, when the grease rises to the top and is drawn off. After the grease is drawn off the tankage is kept agitated, and by evaporation the water is extracted until the tankage contains about 8 per cent moisture. It is then taken out of the tank, allowed to cool, is ground, and stored ready for shipment. This tankage is supposed to contain about 60 per cent protein and 10 per cent fat.

The manufacture of the other tankage is thus described:

> This product, like the one just described, is made from meat scraps, scrap bones, etc. Quoting the words of the manufacturer, it is as follows: "Tankage is the product which drops to the bottom in our rendering tanks when we are rendering out grease, tallow, etc., at our various packing houses. It has been thoroughly cooked under 40 pounds pressure for several hours, which thoroughly destroys any disease germs which might possibly be in the raw meat. This product is

[a] Bul. No. 90, Indiana Expt. Sta.

[b] Bul. No. 65, Iowa Expt. Sta.

pressed and then dried in steam driers at a high temperature. It is then ground and shipped in 100 and 200 pound sacks."

The beef meal, used in the Iowa[a] test, is described as follows:

This product is made from scraps of meat and bone from which the grease has been extracted and the liquors concentrated by cooking. These are then pressed, dried, and ground in preparation for the market. It is claimed to contain from 40 per cent to 50 per cent of protein.

Analyses of packing house by-products.—The analysis of tankage reported by the Indiana Station is as follows:

	Per cent.
Moisture	8.63
Protein	49.81
Ether extract	15.78
Crude fiber	4.78
Nitrogen-free extract	5.06
Ash	15.94
	100

The Iowa Station analyses, including that of the corn meal used, are as follows:

Analyses of feeding stuffs. (Weems.) [a]

Ration.	Water.	Ash.	Protein.	Crude fiber.	Nitrogen-free extract.	Ether extract.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Corn meal	11.05	1.55	15.25	4.85	63.80	3.50
Beef meal	6.10	15.60	61.10	5.20	3.12	8.88
Tankage	6.25	12.85	42.15	6.95	15.50	16.30
Do	9.05	20.65	39.10	10.90	8.60	11.70

[a] Bul. No. 65, Iowa Expt. Sta.

Feeding tankage in a corn-meal ration.—In the Indiana[b] experiment 16 young pigs were fed to determine the value of tankage. The pigs were purebred Poland Chinas and Berkshires. There were 4 lots, 2 of each breed in each lot. The tankage was specially prepared by the packers who furnished it to the experiment station, and was "made from bones and meat taken from the cutting room, tanked immediately, and pressed and dried."

The conditions of the experiment were equal for all lots; all had an opportunity for getting exercise and each lot was in a separate inclosure. There was no sickness and Lot III was the only one showing lack of appetite at any time. The pigs were fed as follows: Lot I, 10 parts corn meal and 1 part tankage; Lot II, 5 parts corn meal and 1 part tankage; Lot III, corn meal; Lot IV, 10 parts of a mixture of equal parts of corn meal and shorts and 1 part tankage. The feed was weighed out and then mixed with tepid water in the proportion of about 2 parts of water to 1 part of feed, a slop of medium thinness being made. Each lot of pigs had access to ashes and salt. The cost

[a] Bul. No. 65, Iowa Expt. Sta. [b] Bul. No. 90, Indiana Expt. Sta.

of feed used was as follows: Corn meal, $20 per ton; shorts, $16 per ton; tankage, $30 per ton.

At the Iowa Station[a] five lots of 6 pigs each, averaging 205 pounds, were fed for forty-nine days, to note the value of packing-house products. "Each lot contained 3 crossbred Poland China-Yorkshires, 2 Poland China-Duroc Jerseys, and 1 Poland China-Berkshire." Corn was used as the basis of comparison and the pigs were fed as follows: Lot I received corn meal alone; Lot II received about 5 parts of corn meal and 1 part of beef meal;[b] Lot III received about 5 parts of corn meal and 1 part of digester tankage; Lot IV received about 5 parts of corn meal and 1 part of tankage.

The market prices of the corn meal and tankage are given as follows: Corn meal, $22 per ton; digester tankage, $32 per ton; tankage, $25 per ton.

The Iowa pigs were shipped to Chicago and the lots were sold separately. They brought $7.55, the extreme top of the market for the day of sale.

The following table shows the results of these experiments:

Tankage in a corn-meal ration for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.
						Grain.	Tankage.	Grain.	Tankage.	
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dollars.*
Indiana:										
Corn meal 10 Tankage 1	4	59	589	127	1.16	1,982	197	337	33	3.80
Corn meal 5 Tankage 1	4	58	625	127	1.23	1,984	379	317	61	4.00
Corn meal	4	58	342	127	.67	1,779	--------	520	--------	5.20
Corn meal and shorts 10 Tankage 1	4	58	579	127	1.14	2,001	199	346	34	3.60
Iowa:										
Corn meal	6	197	596	49	2.08	2,747	--------	461	--------	5.10
Corn meal and digester tankage	6	202	757	49	2.57	2,429	458	321	61	4.50
Corn meal Tankage	6	198	668	49	2.27	2,438	460	365	69	4.90

These experiments seem to show that tankage has a great deal of value for balancing a pig's ration.

In the Indiana test the use of tankage lessened the amount of grain required per 100 pounds gain from 203 pounds to 175 pounds—from 38.9 to 33.5 per cent—showing tankage to be very profitable with the prices that were charged for grain in this instance.

[a] Bul. No. 65.

[b] One lot of pigs in this experiment were fed to note the value of condimental feeds. (See pp. 133, 134 for the results.)

In the Iowa test 140 pounds and 96 pounds, respectively, were saved by the use of tankage—30.4 and 20.8 per cent—not so good a record as obtained in Indiana. The difference between the money cost per 100 pounds of the corn-fed and tankage-fed lots was also much less than in Indiana.

The condition of the pigs in the Indiana test was remarked upon. The tankage-fed pigs handled better, had finer, silkier coats, and ate with much more relish than those on corn alone. The corn-fed lot was conspicuous by reason of its poor condition.

At the conclusion of their experiments, Plumb and Van Norman gave the pigs that had been on corn meal a ration of 5 parts of corn meal and 1 part tankage for forty-nine days. There was immediate improvement in their appetites, the hair softened, and the skin handled better. There was a marked improvement in growth, which contrasted strongly with the gains made while on corn meal only.

Experimenters caution stockmen to use that tankage only which has been specially prepared for feeding purposes.

Beef meal in a corn meal ration.—The results of the lot of pigs that were fed beef meal at the Iowa Station are compared below with those on corn meal. The price of the beef meal used in this test was $22 per ton.

Beef meal in a corn-meal ration for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.
						Grain.	Beef meal.	Grain.	Beef meal.	
		Lbs.	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Dolls.
Corn meal	6	197	596	49	2.08	2,747		461		5.10
Corn meal 5 parts, beef meal 1 part	6	197	707	49	2.40	2,448	458	346	65	4.80

Beef meal, like tankage, seems to be valuable in the pig's ration. The amount of grain saved per 100 pounds gain by the use of beef meal was 115 pounds, or 24.9 per cent.

SUGAR BY-PRODUCTS.

Feeding beet molasses.—Clinton[a] fed 5 pigs averaging 87 pounds on a ration of corn meal 8 pounds, beet molasses 12 pounds, and skim milk 20 pounds. "This quantity was given in two daily feeds, and the pigs apparently did not relish the molasses, yet they ate it." Three days after feeding commenced they ate the morning feed well, but within an hour 1 pig was dead and another died a few hours later. Postmortem examination indicated poisoning. The surviving pigs were then placed on a corn meal and milk ration, but made expensive gains, the cause assigned being the effect of molasses feeding.

[a] Bul. No. 199, Cornell Univ. Expt. Sta.

This experiment had results similar to those of German investigators with beet molasses. It may be that this by-product is not a safe feed for pigs. However, other molasses by-products in sugar production, such as cane molasses, are valuable for feeding horses, cattle, and sheep, and many farmers value highly the "skimmings" from sorghum vats as a fattening feed for pigs. There are very few experimental data on the feeding value of the by-products from sugar refining.

CONDIMENTAL FEEDS.

Two experiments are noted which deal with the value of condimental stock feeds in pork production. These feeds have quite general use over the country, and, on account of strict legislative regulations and the supervision and analyses by the experiment stations, they are generally of high feeding value, having a high nutrient content. They are prepared with palatability in view and often contain some harmless drug that increases the attractiveness of the feed and may have a good effect on the digestive functions. They are thus frequently found valuable where animals are being crowded or are suffering from the effects of improper feeding. Oil meal usually forms the basis of these feeds and is supplemented by bran, bean meal, cotton-seed meal, ginger, fenugreek, etc. These feeds range in price per ton from $30 to $500. The manufacturers generally direct that they be used in very small amounts.

Feeding experiments.—At the Indiana Station Plumb[a] fed two lots of 4 pigs each to determine the value of American stock food. The pigs were gilts, four months old. There were 3 Poland Chinas and 1 Chester White in each lot. The experiment lasted one hundred and twenty-two days. Lot I was fed a mixture of equal parts of shorts and hominy feed and a small amount of American stock food; Lot II received the same ration without the stock food. At the Iowa Station Kennedy and Marshall[b] fed two lots of 5 crossbred pigs each averaging 205 pounds. One lot on corn meal and Standard stock food was compared with a lot on corn meal alone. The following are the results of the two tests:

Feeding pigs with and without stock food.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.	Profit per pig.
						Grain.	Stock food.	Grain.	Stock food.		
Indiana:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Stock food	4	66	682	122	1.42	2,547	64	373	9.38	3.00	[c]9.66
No stock food	4	65	689	122	1.43	2,581	....	375	....	2.60	[c]13.94
Iowa:											
Stock food	5	197	655	49	2.23	2,858	14	436	2.14	5.00	2.64
No stock food	5	197	596	49	2.08	2,747	....	461	....	5.10	2.39

[a] Bul. No. 93. [b] Bul. No. 65. [c] Profit per lot.

The Indiana results show that nothing was gained by the use of the prepared feed; in fact, there was indicated a decided disadvantage, as more feed was required per 100 pounds of gain and the profits were very much less than with the lot not having the prepared feed.

The Iowa results show a saving in cost of 10 cents per 100 pounds gain for the pigs receiving Standard stock food and a net profit per pig of 25 cents in favor of this lot as compared with pigs on corn meal alone. It is needless to point out that the results of these two experiments should not be too closely compared. In addition to the stock food given one lot, all the Indiana pigs were on a mixed ration; whereas in the Iowa test the stock food was the only variation from corn meal that was permitted. The results from adding any palatable feed to a straight corn-meal ration will be greater than the addition of the same or a similar feed to a mixed ration, because in the one case variety is the greatest necessity of the ration, while in the other it is already present. The same, if not very much better, results would have been seen had pigs on a ration of corn meal and green or succulent feed or dairy by-products been compared with pigs on a ration of corn meal only; and oil meal would probably have had a similar effect. While some of the difference in results may have been due to a difference in the quality of the two stock foods, it would naturally be expected that not only a better showing in rate and economy of gain for the stock food when conditions resemble those of the Iowa test would be made, but it would also be expected that there would be a relatively greater showing from the standpoint of total feed eaten. Both of these results are manifest; indeed, in the Indiana test the stock food seems to have had no effect whatever on the appetite.

Plumb[a] mentions a test by a student at Purdue University where Rauh's stock food was fed to 3 pigs for thirty-five days, after which they received Standard stock food for forty-nine days. They had equal parts of corn meal and shorts, and were compared with a lot of 3 pigs on corn meal and shorts only. There was a total gain of 2.5 pounds in favor of the prepared food first mentioned. The total balance was 21 pounds of gain in favor of the condimental feed. The results were as follows:

Feeding pigs with and without stock food.

Ration	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.		Cost per 100 pounds gain.	Total profit.
					Grain.	Stock food.	Grain.	Stock food.		
	Pounds.	*Pounds*		*Pounds.*	*Pounds.*	*Ounces.*	*Pounds.*	*Ounces.*	*Dollars.*	*Dollars.*
Stock food	63	387	84	1.54	1,355	100	350	25.8	4.19	6.98
No stock food	63	366	84	1.45	1,325	--------	362	--------	4.22	6.50

[a] Bul. No. 93, Indiana Expt. Sta.

These results favor the stock food in about the same proportion as in the Iowa test.

DAIRY BY-PRODUCTS.

The use of the by-products of the dairy and creamery (skim milk, buttermilk, and whey) is one of the most interesting subjects of study in pork production. The value of the milk is known on every farm, although it may not be fully appreciated, and anyone who has fed pigs knows the keen appetite that these animals have for milk and its products. In the neighborhood of many large dairies pork production has become a very prominent and lucrative branch of the dairy industry.

Regarding solely their chemical composition, the by-products of the dairy contain most of the indispensable feeding constituents of the milk from which they are produced.

The residue from the separation of cream (skim milk) and that from churning (buttermilk) leave two products that contain practically all the protein and carbohydrates of the whole milk. In cheese making, the whey that is left is the least valuable of the dairy by-products, the greater part of the casein and fat of the milk being retained in the cheese. While whey is by no means worthless for feeding purposes, it can readily be seen that if skim milk and buttermilk have higher feeding values for pigs than whey, butter making and pig feeding will more profitably accompany each other than will cheese making and pig feeding. These by-products supply growing material to young animals and provide an excellent nitrogenous balance in the fattening ration. The constituents that remain in the milk after skimming and churning are the most expensive ones, considered from the standpoint of feeding and fertilizing value, and it is largely due to this fact that dairy farming is so often a profitable business when conducted in a thorough manner.

The value of dairy by-products is not alone in their nitrogenous character. They have an effect on the digestion that brings results out of all proportion to their nutritive value. Where pigs have been for a long time on a monotonous ration, such as corn meal alone, they lose appetite, become listless, and sick, and so make very unsatisfactory gains. If skim milk is given, even in very small amounts, an immediate change for the better is noticed—appetite returns and the pigs begin to gain rapidly in weight. As already stated, the gain in weight is out of all proportion to the actual amount of nutrient material in the milk, and this peculiarity has been remarked upon, not only when pigs are fed as indicated above, but also when pigs are fed a varied grain ration and skim milk in comparison with others on the grain ration only. Just why dairy by-products have this effect is not exactly known, but the suggestion has been made that

they keep the digestive system in better order, and thus enable the animal actually to digest a greater percentage of his feed. The same fact has been noticed when roots and green feed are fed. Pasturing on rape, alfalfa, or the grasses probably has a similar effect.

The effect of dairy by-products on the carcass is one of the most important results of such feeding. It is generally admitted that, while excellent hams and bacon may be produced without dairy by-products, the use of these by-products will result in pork of a more nearly uniform high quality.

THE FEEDING VALUE OF DAIRY BY-PRODUCTS.

Comparing grain and milk rations with rations of grain alone and milk alone.—Linfield[a] reports the results of a series of investigations at the Utah Station. In all, seven distinct experiments are given. Except in one experiment, the pigs were confined on the north side of a barn, were furnished plenty of bedding, and allowed a small run. When grain alone was fed it was mixed with water to form a thin slop, and when milk was fed with grain it was mixed in the same manner. The milk was never given sour. The hogs had access to pure water, had charcoal and ashes in the pens, and were fed twice daily. These experiments were conducted primarily with the object of comparing the value of feeding a combination of grain and skim milk with both grain alone and skim milk alone. They varied somewhat in details, and some difficulty seems to have been experienced in obtaining as much milk as the circumstances required.

The grain was fed in various combinations with the milk, and was usually that which was available in that section for feeding purposes. It consisted of equal parts of barley and bran, corn and wheat, wheat and bran, and corn meal and bran, and in two experiments ground wheat. Whey was fed in the fifth, sixth, and seventh experiments; it formed not over 12 per cent of the by-product in the fifth, but was as much as 40 per cent in the last two. It was a matter of remark that the results in these experiments were fully equal to those where skim milk was fed throughout the entire feeding period, which shows that whey has quite a high feeding value.[b] The quantity of skim milk in the lots fed milk and grain in comparison with grain alone or milk alone varied from 4 to 6 pounds of milk per pound of grain fed at the beginning of the experiment, the amount of milk being gradually decreased with the age and weight of the pigs. The pigs used were well bred, usually being Berkshires, Berkshire grades, or Poland China grades. The following table is a summary of these experiments.

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[a] Bul. No. 57.

[b] See Ontario Agricultural College experiments with sweet and sour whey, pp. 147, 148.

Economy of skim-milk feeding.[a]

Ration.	Number of tests.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.
			Pounds.	*Pounds.*		*Pounds.*
Milk and grain	8	27	40	169	133	1.27
Grain	5	15	63	110	121	.91
Milk	4	11	39	74	108	.68

Ration.	Feed eaten per 100 pounds gain.		Dry matter per 100 pounds gain.	Digestible dry matter per 100 pounds gain.	100 pounds milk equal pounds gain.	Average amount feed eaten per day.	
	Grain.	Milk.				Grain.	Milk.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Milk and grain	292	768	334	258	23.2	3.73	9.74
Grain	470		421	319		4.41	
Milk		3,312	298	285	14.2		22.28

[a] Bul. No. 57, Utah Expt. Sta.

These results indicate that, in rate of gain, an average of eight tests with a grain-and-milk ration shows gains made one-third faster than in five tests with grain alone, and nearly twice as rapidly as in four tests with milk alone. The least amount of dry matter required for 100 pounds of gain was that with the pigs on milk alone, but the pigs on grain and milk required the least digestible dry matter per 100 pounds gain. The returns from skim-milk feeding are estimated by Linfield at 17 cents per 100 pounds of skim milk when grain and milk were fed and 10 cents per 100 pounds of skim milk when milk alone was fed, grain being valued at 75 cents per 100 pounds.

These experiments show that pigs fed on grain and milk are enabled to eat much more feed than those on grain alone; those on grain and milk ate 4.24 pounds of dry matter per head daily; the pigs on grain alone 3.93 pounds of dry matter per head daily, and the daily average of the pigs on milk alone was only 2 pounds of dry matter. This is a point of great importance, and, with the figures showing rate and economy of gains, illustrates the fact that skim milk fed to pigs with grain enables them to eat more feed and to make more gain than pigs on grain alone.

The unsatisfactory character of the gains made by the pigs on skim milk alone is very apparent. This method of feeding should never be resorted to.

Corn and dairy by-products.—At the Tennessee Station Soule and Fain[a] fed four lots of pigs to compare a corn-meal and water ration with others, in which skim milk and whey were used. The pigs were high-grade Chester Whites and were confined in pens. The rations were as follows: Lot I was fed 6 pounds of corn meal and 10 pounds of water at the beginning of the experiment, increasing to 8 pounds of corn meal and 16 pounds of water toward the close. Lot II had 6

[a] Vol. XV, Bul. No. 1.

pounds of corn meal and 18 pounds of skim milk at the beginning, increasing to 8 pounds of corn meal and 40 pounds of skim milk toward the close. Lot III had 4 pounds of corn meal and 12 pounds of skim milk for the first fifteen days and 1.75 pounds of wheat meal, 6.25 pounds of corn meal, and 40 pounds of whey toward the close. Lot IV was fed 2.66 pounds of corn meal, 4 pounds of cowpea hay, and 8 pounds of skim milk at the beginning, which was changed to 5.5 pounds of corn meal, 1.5 pounds of chopped cowpea hay, and 26.75 pounds of skim milk toward the close.

These rations were the amounts of feed that each lot received at a single feed, so that the daily ration for one lot of pigs was double the amounts given above. The feeds were valued as follows: Corn meal, $17 per ton; pea hay, $13.50 per ton; wheat meal, $25 per ton; skim milk, 22 cents per 100 pounds; whey, 11 cents per 100 pounds. The results were as follows:

Economy of skim-milk feeding.

Ration.	Number of pigs.	Total gain.	Number of days fed.	Average daily gain.	Total dry matter eaten.	Dry matter per 100 pounds gain.
		Pounds.		*Pounds.*	*Pounds.*	*Pounds.*
Corn meal	3	186	60	1	775	416
Corn meal and skim milk	3	414	60	2.3	1,213	293
Mixed grain, skim milk, and whey	3	402	60	2.2	1,090	271
Corn meal, cowpea hay, and skim milk	2	246	60	2.0	1,017	414

Ration.	Total cost of feed.	Cost of feed per 100 pounds gain.	Net profit.[a]	Slaughter test.	
				Dressed weight.	Intestinal fat.
	Dollars.	*Dollars.*	*Dollars.*	*Per cent.*	*Pounds.*
Corn meal	7.39	3.90	7.69	73.6	13
Corn meal and skim milk	17.61	4.20	12.06	78.5	16
Mixed grain, skim milk, and whey	13.84	3.40	14.89	76.2	16
Corn meal, cowpea hay, and skim milk	12.97	5.20	4.12	77.7	9

[a] Value of manure and cost of care and feed considered.

The pigs were bought on the Knoxville market at 4½ cents per pound and weighed from 130 to 140 pounds at the time of purchase. They were sold at 5½ cents per pound.

The great advantages to be gained by feeding dairy by-products with carbonaceous concentrates are brought out in the results. The pigs on corn meal alone ate less than any others, and although their cost of feed was low they were not so profitable as those fed milk and grain, which ate very much more. An exception to the general rule is seen in Lot IV, which were fed very unprofitably.

With the pigs selling at 5½ cents per pound live weight, the authors estimate that this experiment returned, for the corn fed, 66.7 cents per bushel of 56 pounds, which is said to be 26.7 cents per bushel more than Tennessee farmers usually get for their corn. The feeding value of skim milk in this test was, approximately, 28.3 cents per 100 pounds

During the two years following the above experiment Soule and Fain[a] studied the value of skim milk in a corn-meal ration and in a mixed-meal ration. The pigs of the first year were of Chester White and Berkshire blood, some being Chester grades and others said to be Chester White-Berkshire crosses. They were above the average in quality. Those of the second year were Berkshire grades, below the average of the preceding year. The pigs were confined in pens and fed twice daily. Feeding was carried on through the winter. The first winter "was cool and bracing and uniformly dry;" the second "was raw and damp, with an excessive rainfall, and this no doubt had an influence on the general health of the hogs."

The lots which were used to compare a straight corn-meal ration with a corn-meal and skim-milk ration received, respectively, rations of corn meal only and corn meal and milk in the proportion of 1 to 8 by weight at the start, the milk being decreased toward the close so that the proportion of meal to milk was about 1 to 7.

Corn meal was charged at $28 per ton during the first year and at $19 per ton during the second year. Skim milk was charged at $4 per ton during both years.

The following table shows some of the results of this investigation. The findings of the two years were averaged, from which average these figures are taken:

Economy of skim-milk feeding.

Ration.	Number of pigs.	Total gain.	Average daily gain.	Total feed eaten.	
				Grain.	Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Corn meal	7	119	0.50	489	
Corn meal and skim milk	7	309	1.35	481	3,686

Ration.	Feed per 100 pounds gain.		Total cost of feed.	Cost of feed per 100 pounds gain.	Profit per group.[a]
	Grain.	Milk.			
	Pounds.	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*
Corn meal	410		5.75	5.80	1.05
Corn meal and skim milk	160	1,190	12.95	4.60	4.96

[a] Value of manure and cost of care not considered.

The favorable results from the feeding of skim milk with corn meal are very noticeable in these results. Although the addition of skim milk added to the cost of the total feed and the feed per 100 pounds gain was accordingly higher, the profit for the pigs on skim milk was $3.91 more than that of those on corn alone.

Value of skim milk in a mixed ration.—As part of the investigation of the years just mentioned, Soule and Fain[a] studied the value of

[a] Vol. XVI, Bul. No. 3, Tennessee Expt. Sta.

skim milk in various proportions with a mixed ration of corn meal and wheat meal or corn meal and soy-bean meal. The proportions of these grains was 1 part of wheat or soy-bean meal to 2 parts of corn meal. The following prices per ton were charged for the feed:

	First year.	Second year.
	Dollars.	*Dollars.*
Corn and wheat meal	29	22
Corn and soy-bean meal	33	25
Corn meal	28	19
Skim milk	4	4

The conditions were those described in the foregoing paragraph. The following table shows some of the results of the averages for the two years as published by the station:

Value of skim milk in a mixed-grain ration.

Ration.	Number of pigs.	Total gain.	Average daily gain.	Total feed eaten. Grain.	Total feed eaten. Milk.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Grain 1, Milk 3	7	314	1.35	682	2,046
Grain 1, Milk 6	7	306	1.30	590	2,046
Grain 1, Milk 8	7	304	1.30	487	3,699
Grain 1, Milk 9	7	331	1.40	517	4.654
Grain 1, Milk 12	7	320	1.40	436	5,226
Grain 1, Milk 8 [a]	7	307	1.30	491	3,731

Ration.	Feed per 100 pounds gain. Grain.	Feed per 100 pounds gain. Milk.	Total cost of feed.	Cost of feed per 100 pounds gain.	Profit per group.[b]
	Pounds.	*Pounds.*	*Dollars.*	*Dollars.*	*Dollars.*
Grain 1, Milk 3	220	650	12.46	4.40	7.63
Grain 1, Milk 6	190	1,160	14.35	5.10	5.27
Grain 1, Milk 8	160	1,220	13.54	4.80	4.13
Grain 1, Milk 9	160	1,410	15.67	5.10	5.62
Grain 1, Milk 12	140	1,640	15.83	5.30	4.77
Grain 1, Milk 8 [a]	160	1,220	14.49	5.10	3.38

[a] The grain to this lot was corn meal 2 parts, soy-bean meal 1 part. That to all the other lots was corn meal 2 parts, wheat meal 1 part.

[b] Value of manure and cost of care not considered.

The most economical ration is seen to be one in which the proportion of grain to skim milk was as 1 to 3. Beyond a certain point, it was found to be expensive to give the pigs a large amount of skim milk. However, all the lots receiving the dairy ration made good gains; the only one of the two years' tests which made an extremely poor showing was that on corn meal alone.

Skim milk compared with nitrogenous concentrates.—In order to compare the value of skim milk as a balance with that of a mixture of gluten and linseed meals Patterson[a] fed two lots of pigs of 6 each at the Maryland Station. Lot I received a ration as follows: Hominy chop, 300 pounds; ground corn fodder (new corn product), 100 pounds; skim milk, 2,400 pounds. Lot II received: Hominy chop, 300 pounds; ground corn fodder, 100 pounds; King gluten meal, 100 pounds; and linseed meal, 200 pounds. The grain was fed as a slop. Results were as follows:

Skim milk compared with nitrogenous concentrates.

Ration.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Feed eaten per 100 pounds gain.		Nutritive ratio.
					Grain and fodder.	Milk.	
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	
Grain, fodder, and milk	66	187	121	1.54	300	1,272	1:3.52
Grain and fodder	57	136	121	1.12	407	----------	1:3.61

This experiment seems to bear out the contention that skim milk has more value as a feed than is indicated by the digestible nutrients it contains. The use of milk effected a saving of practically 25 per cent of grain in the feed required for 100 pounds of gain. The rations fed were identical in nutritive ratio, and they were made up of the same feeds, except that one was balanced with skim milk and the other with gluten and linseed meals. The great difference between the feeding values of the two rations must be ascribed to the effect of skim milk on the digestive system, and it would seem that a ration may be balanced in other ways than by the addition of certain proportions of nutrients with certain fuel values—a "balanced ration" being regarded as the one that gives the best results when fed for a certain purpose.

A comparison of skim milk and green clover in a pig's ration.—At the Maryland Station, Patterson,[a] fed two lots of Duroc Jersey and Berkshire grades of 6 pigs each on rations, one of which was balanced with skim milk and the other included cut green clover instead of milk. The grain was corn-and-cob meal, 8 parts, and 1 part each of gluten meal and linseed meal. The clover was given only in such

[a] Bul. No. 63.

amount as the pigs would eat. It was not possible to get them to eat enough to balance the ration completely. The feeding period lasted one hundred and sixty-five days.

Skim milk compared with green clover for pigs.

Ration.	Average weight at beginning.	Average gain.	Average daily gain.	Feed eaten per 100 pounds gain.			Digestible dry matter per 100 pounds gain.	Nutritive ratio.
				Grain.	Milk.	Clover.		
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Grain and skim milk	46.3	207.5	1.26	377	1,470		405	1:4
Grain and clover	47.1	99.30	.60	747		145	555	1:6.6

This experiment does not show profitable results from the feeding of green clover as compared with skim milk. The returns for the green clover are not at all satisfactory, very much less so than the results of other tests that have been made.

Corn meal and a mixture of corn meal and middlings in a skim-milk ration.—Clinton[a] reports the results of four years' experimenting at the Cornell University Experiment Station to study the value of certain proportions of skim milk to grain in the ration and the relative value of corn meal and a mixture of corn meal and wheat middlings in such a ration. In two experiments the best results were obtained when the ratios of grain to milk were as 1:3 and 1:2.5; in the other two the best results were with a ration in which the ratios of grain to milk were as 1:6.7 and 1:6.2. There were 133 hogs fed in these tests. The following table has been compiled from the results, and shows the feed required for 100 pounds gain for the two feeds:

Economy of skim-milk feeding.

Ration.	Number of tests.	Number of pigs.	Feed required for 100 pounds gain.	
			Grain.	Milk.
			Pounds.	*Pounds.*
Corn meal and milk	17	81	273	1,016
Corn meal, middlings, and milk[a]	12	52	223	1,069

[a] The proportion of these feeds was 4:1 in three tests. In the fourth it was not stated.

Grain values of skim milk.—The following figures show the grain values of skim milk as obtained under various methods of feeding at Ottawa.[b] The results are combined in the following table:

[a] Bul. No. 199. [b] Bul. No. 33, Central Experimental Farm.

Grain values of skim milk.

Number of pigs.	Skim milk consumed per head daily.	Milk value of 100 pounds grain.	Kind of grain.	Grain value of 100 pounds milk.
	Pounds.	*Pounds.*		*Pounds.*
4	2	183	Corn	54.64
7	3	183	do	54.64
8	3	354	Barley	28.24
31	3	323	Mixed grain	30.96
4	5.4	538	do	18.69
4	5.41	534	do	18.72
4	13.6	791	Frosted wheat	12.64
5	15.7	699	Mixed grain	14.30
5	15.7	734	do	13.62
2	17.1	882	do	11.33
2	17.14	882	do	11.33
2	23.7	776	do	12.88
4	32.41	834	do	11.99
Average		604		16.55

The average of results obtained by Danish experimenters is a value of about 600 pounds of milk for 100 pounds of grain, but the greater amount of work of this nature in America has shown a higher value for skim milk. The average of nineteen trials in Wisconsin with proportions of milk ranging from 1 to 9 pounds for each pound of grain fed, with hogs of all ages, was that 475 pounds of skim milk were equal to 100 pounds of meal.[a] In Utah[b] Linfield found the value of 100 pounds of milk in terms of grain (that is, the amount of grain replaced by 100 pounds of milk) to be 23.2 and 26.3 pounds, respectively, in two series of experiments. Grisdale[c] values milk at from one-fifth to one-sixth as much as mixed grain. In all experiments the large return where the proportion of milk to grain is small is particularly noteworthy. Milk should never be given to pigs in unlimited amounts except while with the sow, or immediately after weaning, up to the weights of 75 or 100 pounds. At this early age, much grain will disarrange the digestion and best results can be expected from a ration that is largely milk.

Grain required for 100 pounds gain when feeding skim milk and grain as compared with grain alone and milk alone.—The following table is adapted from one compiled by Linfield[d] from the results of various stations for the purpose of showing the cost in grain of feeding rations of grain and skim milk, grain alone, and skim milk alone.

[a] Henry: Feeds and Feeding, p. 572.
[b] Bul. No. 57.
[c] Bul. No. 33, Central Experimental Farm.
[d] Bul. No. 57, Utah Expt. Sta.

Feed per 100 pounds gain.

Station.	Dry matter for 100 pounds gain.		
	Grain and milk.	Grain alone.	Milk alone.
	Pounds.	*Pounds.*	*Pounds.*
Wisconsin	345	455	180
Colorado	298	576	
New Hampshire[a]	231	334	
Utah[a]	334	421	298
	258	319	285

[a] The results in New Hampshire and the second line of Utah results show estimated digestible dry matter.

These figures show what can be regarded as representative values of these three methods of feeding, and emphatically demonstrate the economy of the grain-and-milk combination. Linfield calls attention to the fact that none of the pigs fed milk alone attained a weight of over 100 pounds, whereas some of those in the other columns reached nearly 300 pounds. It does not always mean profitable feeding for a hog to require a small amount of feed to make a certain gain.

Value of milk at various prices for grain.—Using as a basis the results obtained in the investigations already mentioned, Linfield[a] makes the following estimates of the value of skim milk as a supplementary feed in a ration at various prices for grain:

Value of skim milk for pigs.

Ration.	Number of pigs.	Grain equal to 100 pounds skim milk.	Value of skim milk per 100 pounds when grain is worth, per 100 pounds—						
			40 cents.	50 cents.	60 cents.	70 cents.	80 cents.	90 cents.	$1.
		Pounds.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Milk and grain	27	23.2	9.3	11.5	13.9	16.2	18.6	20.9	23.2
Milk	11	14.2	5.7	7.1	8.5	9.9	11.4	12.8	14.2

A similar study was made by Lindsey[b] and others from the results at the Hatch Station, except that the figures do not include the results of feeding on milk alone. The averages of their experiments are given in the following table. "Starchy feeds" refer to such substitutes for corn meal as hominy meal, cerealine feed, rye meal, wheat meal, etc.; "other grains" are the nitrogenous feeds, such as wheat bran, gluten meal, linseed meal, etc.:

[a] Bul. No. 57, Utah Expt. Sta.

[b] Eleventh An. Rpt., Hatch Expt. Sta.

Value of skim milk for pigs.

Cost of feed—	With dressed pork at 5 cents per lb., skim milk is worth—		With dressed pork at 6 cents per lb., skim milk is worth—		With dressed pork at 7 cents per lb., skim milk is worth—	
	Per quart.	Per 100 pounds.	Per quart.	Per 100 pounds.	Per quart.	Per 100 pounds.
	Cent.	*Cents.*	*Cent.*	*Cents.*	*Cent.*	*Cents.*
With corn meal and other starchy feeds at $15 per ton, "other grains" at $17.50 per ton	0.50	23.07	0.67	30.73	0.83	38.19
With corn meal and other starchy feeds at $17.50 per ton, "other grains" at $20 per ton	.45	20.66	.61	28.14	.78	35.86
With corn meal and other starchy feeds at $20 per ton, "other grains" at $22.50 per ton	.39	18.08	.56	25.82	.78	35.70

Cost of feed when feeding skim milk.—The following shows the cost of feed per 100 pounds of live and dressed weight produced as estimated from the Massachusetts[a] experiments at various prices for grain and milk :

Cost of feed per 100 pounds of growth produced.

Cost of feed—	Cost per 100 pounds live weight.	Cost per 100 pounds dressed weight.
	Dollars.	*Dollars.*
With corn meal at $15 per ton, "other grains" at $17.50 per ton, and milk at ¼ cent per quart	2.78	3.47
With corn meal at $15 per ton, "other grains" at $17.50 per ton, and milk at ½ cent per quart	4.00	4.99
With corn meal at $17.50 per ton, "other grains" at $20 per ton, and milk at ¼ cent per quart	3.04	3.79
With corn meal at $17.50 per ton, "other grains" at $20 per ton, and milk at ½ cent per quart	4.25	5.31
Vith corn meal at $20 per ton, "other grains" at $22.50 per ton, and milk at cent per quart	3.63	4.53
Vith corn meal at $20 per ton, "other grains" at $22.50 per ton, and milk at ½ cent per quart	4.51	5.63

The labor cost of feeding.—In experiments in pork production nvestigators almost invariably disregard the expense of care and ıbor, estimating that this will be covered by the value of the manure ıade and the saving in expense of marketing crops. This is always

[a] Eleventh An. Rpt., Hatch Expt. Sta.

more or less of an obstacle in applying the results of experiments to actual farming conditions, for the manure is not always carefully saved on the farm. Linfield,[a] of the Utah Station, studied the labor cost as shown by the experience of some of the creameries in his State that were feeding large numbers of hogs, and states the result of his inquiries as follows:

One creamery reports that one man would feed 1,000 hogs, clean all the pens each day, and draw the grain feed from the mill 2 miles distant. Another says that one man does all the work of feeding and cleaning out the pens for 500 hogs in five hours each day. The wages paid in each case was about $1 per day.

At both creameries the hogs are purchased when weighing from 50 to 100 pounds each, though some few are heavier. The hogs are crowded from the start, and at most not more than 100 days are required to fit the hogs for market, and in this time 100 to 125 pounds have been added to the live weight of each hog.

By putting all of the above figures together we find that it costs five hours' labor or 50 cents to look after 500 hogs for one day, or $50 to look after 500 hogs for one hundred days. This is 10 cents for 1 hog for one hundred days, or for 100 pounds gain, which gives one-tenth of a cent as the labor cost of producing 1 pound of live weight of hog. It is thus evident from the results of these practical men that when handled in large numbers, as hogs may be at a creamery, the labor is a very small item in growing the hogs. If the value of the gain was reckoned at 4 cents per pound the labor cost of producing the pork was but 2½ per cent of its selling price.

Lest these results be misleading, Linfield calls attention to the fact that the conditions were almost ideal for the greatest economy, the hogs were "short fed," and all feeding appliances and pens were so arranged as to have in view the greatest possible saving of labor. At another creamery, where the hogs were raised on the place and fed until they were fifteen months old and the accommodations were not so good, the cost reported was as large for 300 hogs as the others reported for 1,000 head. It is pointed out that, on the average farm, where the number of animals is much smaller, and milk must usually be hauled back to the farm, the labor cost will be very much greater.

Skim-milk rations for growing pigs.—The Hatch Station[b] recommends the following rations for pigs weighing from 20 to 180 pounds when the feeder has an unlimited supply of skim milk at hand:

Rations for growing pigs.

Weight of pigs.	Rations.
20 to 60 pounds	3 ounces of corn meal to each quart of milk.
60 to 100 pounds	6 ounces of corn meal to each quart of milk.
100 to 180 pounds	8 ounces of corn meal to each quart of milk.

[a] Bul. No. 57.

[b] Eleventh An. Rpt.

The following rations may be used where the milk supply is in limited amounts:

Rations for growing pigs.

Weight of pigs.	Rations.
20 to 180 pounds	3 ounces of corn meal, wheat, rye, or hominy meals to each quart of milk, and then gradually increase meal to satisfy appetites.
20 to 60 pounds	Milk at disposal, plus mixture of one-third corn meal, one-third wheat bran, and one-third gluten meal to satisfy appetites.
60 to 100 pounds	Milk at disposal, plus mixture of one-half corn meal, one-fourth wheat bran, and one-fourth gluten meal to satisfy appetites.
100 to 180 pounds	Milk at disposal, plus mixture of two-thirds corn meal, one-sixth wheat bran, and one-sixth gluten meal to satisfy appetites.
20 to 60 pounds	3 ounces of corn meal to each quart of milk, and 4 ounces of gluten feed as a substitute for quart of milk.
60 to 100 pounds	Milk at disposal, and mixture of one-half corn meal and one-half gluten feed to satisfy appetites.
100 to 180 pounds	Milk at disposal, and mixture of two-thirds corn meal and one-third gluten feed to satisfy appetites.

Sweet compared with sour whey.—At the Ontario Agricultural College, Day[a] conducted five experiments to compare the feeding values of sweet and sour whey. Each experiment was preceded by a preliminary period of from one to two weeks and the experiments proper varied in duration from twenty-nine to sixty-four days. In each one as a check a group of pigs was fed on meal only mixed with water. The group receiving whey had it mixed with the grain, and both lots received the same quantity of whey, which was about 2 pounds to each pound of meal. All lots had as much feed as they would eat readily. The sour whey fed in 1897 "was kept in a tank which had not been cleaned since early in the summer of 1896." The meal was a mixture of equal parts of pease, barley, and oats.

The following table shows the amount of grain saved by feeding whey for each experiment and for the average:

Grain saved by feeding sweet and sour whey.

Experiment.	Amount of meal saved by 100 pounds of sweet whey.	Amount of meal saved by 100 pounds of sour whey.
	Pounds.	*Pounds.*
No. 1 (1896)	13.32	13.61
No. 2 (1896)	13.32	13.81
No. 3 (1897)	14.88	7.87
No. 4 (1897)	No test.	10.07
No. 5 (1897)	6.08	9.34
Average	11.90	10.94

[a] An. Rpts., 1896 and 1897.

Whey feeding is often attended with difficulty, as it causes a stiffening of the joints and serious lameness. This condition occurred in the experiments of 1896; and in 1897 the group fed sweet whey in experiment No. 4 was so seriously checked by this trouble that they were left out of the comparison. Day calls particular attention to the fact that the lots receiving sour whey were not at all affected.

If experiment No. 4 is omitted in the preceding table, the average amount of meal saved by 100 pounds of sour whey is 11.15 pounds. The value of whey in pork feeding is, according to these figures, about half that of skim milk.

The following shows the results of six analyses of whey made during these experiments by the chemical department of the Ontario Agricultural College:

Composition of whey.

	Sweet whey.	Sour whey.
	Per cent.	*Per cent.*
Nitrogenous matter	0.920	0.973
Sugar	4.709	.081

Day suggests that the higher percentage of nitrogenous substances in the sour whey was perhaps due to evaporation of the original samples.

PASTURE AND PASTURE SUBSTITUTES.

PASTURE.

Value of pasture with a grain ration.—The Utah Station[a] has devoted considerable study to the effect and value of pasture for pigs that are on a grain ration. The pastures used were made up of mixed grasses and alfalfa. The Utah problem in pork production is defined as the use of "a minimum amount of grain and a maximum amount of alfalfa, milk, and whey, or other cheap foods." The following table shows the results of four seasons' study of this problem, where rations of grain and pasture and grain alone were compared:

Value of pasture with grain.

Ration.	Feed eaten daily.	Total gain.	Average daily gain.	Feed eaten per 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Grain and pasture	4.72	247	1.21	385
Grain	4.05	185	.94	430

These results strongly favor the use of pasture when feeding pigs under conditions similar to those that exist in Utah. In every respect the pigs on pasture show better results than those that had no pasture; the total gain per head averaged 33 per cent greater for the

[a] Bul. No. 70.

pigs on pasture than for those on grain alone; the average daily gains were nearly 29 per cent greater, and there was a saving of more than 10 per cent in the feed per 100 pounds gain for the pigs on pasture.

Value of a grain ration with pasture.—The converse of the Utah experiments is shown by two experiments by Morrow and Bone[a] in Oklahoma.

Two lots of 4 pigs each were placed in half-acre alfalfa lots, one being given a full feed of grain and the other receiving none. In eight weeks the lot without grain had gained only 68 pounds, or 17 pounds each, and those having grain gained 324 pounds, or 81 pounds each.

A sow with a litter of 5 pigs was in the same lot with the grain-fed pigs. The sow gained 61 pounds in thirty-five days, when she was removed. Her 5 pigs made a total gain of 146 pounds in the first five weeks and 96 pounds during the succeeding period of three weeks. The grain fed these pigs amounted to only 221 pounds per 100 pounds gain.

Pasture in addition to dairy by-products.—Four tests were made in Utah[b] to determine the value of pasturing pigs that are receiving a ration of grain, milk, and whey. One test was made with pasturing pigs that were receiving milk and whey, but no grain. The ratio of milk to grain by weight was 5:1 at the start and 3:1 at the close in the second and third tests. In the fourth test the grain was limited to one-half the quantity fed the other lots, but all the milk and whey was given that the pigs would take.

The pigs that received the grain and dairy by-product ration were fed in pens.

The following table shows the results for each test and the average of all:

Value of pasture with dairy by-products.

Ration.	Total gain.	Average daily gain.	Feed eaten daily.		Feed per 100 pounds gain.	
			Milk.	Grain.	Milk.	Grain.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Milk[a] and pasture	218	0.69	21.00	----------	3,034	----------
Milk	202	.64	23.54	----------	3,672	----------
Milk, grain, and pasture	350	1.11	9.56	3.34	859	300
Milk and grain	366	1.16	10.71	3.13	921	269
Milk, grain, and pasture	324	1.25	10.11	3.38	805	269
Milk and grain	351	1.35	11.52	3.24	879	238
Milk, grain, and pasture	273	1.05	15.65	1.09	1,479	139
Milk and grain	284	1.10	18.12	1.62	1,837	147
Average with pasture	291	1.03	14.08	2.60	1,544	236
Average without pasture	301	1.06	15.97	2.66	1,827	218

[a] By "milk" is meant both milk and whey.

The results of the first test bear out previous experience with attempts to make pork on pasture without grain, although the gains

[a] An. Rpt. 1898–99, Oklahoma Expt. Sta. [b] Bul. No. 70, Utah Expt. Sta.

given are fairly good and better than might be expected on a pasture containing only a small amount of alfalfa. The addition of skim milk did not prove beneficial in anyway. In the experiments where grain was fed no advantage accrued through the use of pasture, except that the pasture lots consumed nearly 300 pounds less milk per 100 pounds gain than those in pens. At 15 cents per 100 pounds, this means a difference of 45 cents per 100 pounds of pork made. The difference in grain fed was nearly 20 pounds per 100 pounds of pork made in favor of the pen-fed lots.

These results are evidence in support of the idea that the effect of dairy by-products and succulent feed in the ration is similar, and that to get the greatest amount of gain at the least expenditure of feed only one of the supplementary feeds is necessary; that the addition of pasture to a ration which already contains a large amount of dairy by-products is superfluous; and that the only advantage to be gained by such a method of feeding is the exercise obtained by the pigs on pasture.

Pen compared with pasture feeding.—At the Utah Station, Linfield[a] fed six lots of 3 pigs each, in two tests, to study the value of rations composed of grain and milk, grain alone, and milk alone. Both tests were conducted during the summer and fall of the same year. In one test the pigs had the run of a pasture of mixed grasses in which was a large amount of alfalfa. The following table shows a comparison between pen and pasture feeding:

Pen compared with pasture feeding.

Method of feeding.	Average daily gain.	Dry matter per 100 pounds gain.	Estimated digestible dry matter per 100 pounds gain.	Dry matter eaten per day.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Lots fed on milk:				
On pasture	0.7	256	261	1.79
In pen	.65	310	275	2
Lots fed on milk and grain:				
On pasture	1.12	319	261	3.58
In pen	1.17	320	262	3.78
Lots fed on grain:				
On pasture	.81	355	268	4.35
In pen	.51	443	334	2.28

The only pigs that showed better results in pens than on pasture were those on grain and milk. Those receiving grain alone on pasture gave very much larger gains, required less feed per 100 pounds gain, and ate more feed than those receiving grain alone in pens. Linfield suggests that either the exercise or the feed obtained by the run on pasture gave these pigs greater appetite and enabled them to digest a greater amount of feed daily. The fact that neither of

[a] Bul. No. 57.

the other lots showed a marked advantage from pasture might be explained by the skim milk in the ration. It is perhaps a safe proposition that in feeding pigs the best results will follow the use of dairy by-products, roots, or pasture, in connection with grain, but that it is superfluous to combine two of these supplementary feeds, as their action on the digestive system seems to be similar. When attempts are being made to prevent disease, however, the advantage of ample exercise must not be overlooked.

Corn compared with wheat on alfalfa pasture.—At the Nebraska Station,[a] Burnett and Smith placed three lots of 6 pigs each on alfalfa pasture lots one-fourth acre in area. The pigs were Tamworth-Duroc Jersey crossbreds. Lot I was fed ground corn; Lot II, a ration composed of 95 per cent ground corn and 5 per cent dried blood, and Lot III received ground wheat. In addition to the pasture, all the pigs had one week on rape. The experiment lasted forty-two days. The results follow:

Corn compared with wheat on alfalfa pasture.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average gain.	Average daily gain.	Average amount feed eaten.	Feed per 100 pounds gain.	Cost per 100 pounds gain.	Profit per lot.[a]
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Ground corn	6	146	223	77	1.22	308	400	4.00	3.77
Ground corn 95 per cent; Dried blood 5 per cent	6	145	227	82	1.30	308	376	4.04	3.88
Ground wheat	6	147	229	82	1.30	308	376	4.13	3.83

[a] Expense of pasture and labor considered.

The cost of feed in this experiment was, for corn, $1 per hundredweight; wheat, $1.10 per hundredweight, and dried blood, $2.50 per hundredweight. The results are so close together that a slight change in the prices of feed would change the relative rank of these rations. The value of pasture is apparent when these results are compared with those of the experiment at this station with wheat and other grains. (See p. 98.)

Maintaining pigs on pasture alone.—At the Utah Station Foster and Merrill[b] conducted two tests to observe the effect of maintaining pigs on pasture alone.

According to Henry,[c] no station has shown that pigs can be successfully maintained on pasture alone if the test reported from the Utah Station is excepted. The further investigations at this station on this line are therefore of much interest.

In 1898 a comparison was made of mixed pasture and alfalfa pasture. The pigs were about five months old at the beginning of the test, had been fed grain and milk, and were in a very thrifty condition. Both lots had access to running water.

[a] Bul. No. 75. [b] Bul. No. 70. [c] Feeds and Feeding, pp. 578, 579.

The experiment in 1899 was in some ways a continuation of that of 1898. Two lots of pigs were used; both were on alfalfa pasture, but they differed in age. Lot I consisted of 3 pigs about four months old, and Lot II of 3 pigs about seven months old and nearly twice as heavy as those in Lot I. The following table gives the results of the experiments:

Pigs on pasture without grain or milk.

Ration.	Number of pigs.	Total weight at beginning.	Total weight at close.	Total gain.	Number of days fed.	Average daily gain.
1898.		*Pounds.*	*Pounds.*	*Pounds.*		*Pound.*
Lot I. Mixed pasture	--------	251	321	70	125	0.189
Lot II. Alfalfa pasture	--------	284	280	[a]4	109	.0122
1899.						
Lot I. Alfalfa pasture	3	165	188	23	129	.059
Lot II. Alfalfa pasture	3	330	322	[a]8	110	.024

[a]Loss.

These experiments do not change one's opinion regarding the value of pasture alone for pigs. The two lots gained in weight—one on mixed pasture and the other on alfalfa pasture. The effect of this method of feeding on the appearance of the pigs was very marked; in the 1898 test this was particularly commented upon. "The plump rounded forms gave place to large coarse frames and large stomachs. At the end of the experiment they looked very much larger than at the beginning, but the scales failed to show any gains. What is said above would also apply to the mixed pasture set, only in that case the eye was not so badly deceived—small gains were made."

In 1899 pigs that were receiving small amounts of feed, either milk or grain in addition to pasture, were found to have made gains very nearly in proportion to the amount of extra feed given, which Foster and Merrill regard as evidence that the pasture supplied enough feed for maintenance only.

GREEN SUBSTITUTES FOR PASTURE.

Pasturing on rape.—At the Utah Station Foster and Merrill[a] pastured 6 pigs on a plot of rape that had been seeded August 11, after having been irrigated and plowed. The pigs were hurdled in pens 16 feet square and without shelter from rain or snow. They received a ration of 1 pound daily of a mixture of equal parts of bran and chopped wheat.

At the Canada Central Experimental Farm, Grisdale[b] pastured 6 pigs on a plot three-sixteenths acre in extent that had been drilled to rape, the drills being 30 inches apart. These pigs received a daily

[a]Bul. No. 70. [b]An. Rpt., 1900.

grain ration of 1 pound per head at the beginning, which was increased to 5 pounds at the close. At the Alabama Station, Duggar[a] hurdled pigs, which had been weaned three weeks, on rape drilled on sandy upland the previous October. They received about a half ration of corn meal in addition.

The results are as follows:

Pasturing on rape.

Where fed.	Number of pigs.	Total weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Grain eaten.	Grain per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Utah	6	296	60	49	0.204	294	490
Canada	6	358	869	114	1.27	2,067	238
Alabama	4	130	181	81	.56	524	290

At the close of the Alabama test, the pigs were placed on second-growth rape for three weeks. They grazed one-sixth acre, eating 168 pounds corn meal and making a gain of 82 pounds, which was an average daily gain of 0.98 pound, at a cost of 205 pounds meal for 100 pounds gain. Assuming that 500 pounds of grain alone are required for 100 pounds gain, Duggar[a] estimates the amount of the pork produced per acre from the first and second growth rape together at 512 pounds, worth at that time $20.48.

Seven shoats, averaging 41 pounds in weight, were on rape at the same station for four weeks during the late spring. They received some corn meal in addition. During the first two weeks the rape was fed to the pigs in the pens; during the remainder of the time they were hurdled. They ate 318 pounds of corn meal. The total gain in weight for the four weeks was 103 pounds, an average daily gain of 0.53 pound, 310 pounds of grain and 4,050 square feet of rape being required to produce 100 pounds of gain.

Rape compared with clover.—The Wisconsin Station[b] has reported two experiments comparing rape and clover as pasturage for hogs. In the first, 20 purebred or high-grade Poland China pigs between five and six months of age were used. Lot I was hurdled on rape, had access to water, and had the run of a blue-grass lot. Their grain feed was a mixture of 2 parts of corn meal and 1 part shorts twice daily as slop. Lot II was on a 10-acre lot of second-growth clover, and received the same grain ration as Lot I. In the second experiment the pigs used were purebred and high-grade Berkshires and Poland Chinas. Their grain ration was the same mixture as that used in the first experiment, mixed into a thick slop. Lot I was hurdled on

[a] Bul. No. 122. [b] Sixteenth and Seventeenth An. Rpts.

rape; Lot II had the run of an 8-acre field of second-growth clover. The results were as follows:

Rape compared with clover.

Ration.	Number of pigs.	Total weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Grain eaten.	Grain per 100 pounds of gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Grain and rape	20	2,111	1,043	63	0.87	4,083.75	392
Grain and rape	21	2,139	1,492	56	1.27	4,965	333
Average							362
Grain and clover	20	2,091	941	63	.78	4,083.75	434
Grain and clover	21	2,136	1,435	56	1.22	4,965	346
Average							390

These experiments give rape a greater value for pigs than clover pasture. Rape has an advantage of over 7 per cent in grain required per 100 pounds of gain.

The influence of rape on grain eaten.—At the Wisconsin Station Carlyle[a] fed two lots of pigs—one lot hurdled on rape pasture and the other fed in a roomy yard without any kind of green feed. Both lots received the same grain ration, which was a mixture of equal parts of corn meal and shorts made into a slop immediately before feeding, and had coal ashes at all times. The experiment began August 4, when the rape was about 20 inches high. The pigs used were about four months old at the beginning of the experiment, and represented the Poland China, Berkshire, and Yorkshire breeds. The following is a summary of the results:

Value of rape with grain.

Ration.	Total weight at beginning.	Total weight at close.	Grain eaten.	Total gain.	Average gain.	Average daily gain first six weeks.	Average daily gain second six weeks.	Grain per 100 pounds gain.	Cost of grain per 100 pounds
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pound.*	*Pounds.*	*Pounds.*	*Dollars.*
Lot I, without rape	1,017	2,211	5,642	1,194	70.2	0.71	1.08	437	3.78
Lot II, with rape	1,001	2,412	5,920	1,411	83	.88	1.23	420	3.36

Exclusive rape feeding.—At the Wisconsin Station Carlyle[b] fed two lots of pigs on rape alone for two weeks. Two lots of 18 pigs each were taken from rations composed of grain exclusively, grain and clover, and grain and rape. They were given nothing but rape. They fed nearly all day, appeared contented, and scoured but little, but 25 of

[a] Eighteenth An. Rpt. [b] Seventeenth An. Rpt.

the 36 lost in weight during the two weeks. They were on rape, and only 4 made gains. The total loss on 36 pigs was 60 pounds, or at the rate of $1\frac{2}{3}$ pounds per pig. The 6 pigs that had been on an exclusive grain diet lost 18 pounds, or 3 pounds each. The 8 pigs that had been on grain and clover lost 19 pounds, an average of nearly $2\frac{1}{3}$ pounds each, and the 22 pigs that were taken from a grain and rape diet lost 33 pounds, or $1\frac{1}{2}$ pounds each.

Soiling.—The Utah Station[a] reports the results of seven tests of the value of green feed to pigs in pens and yards on full grain and one-fourth grain rations. In four tests the pigs were in pens and in three they were in open yards. The green feed was mainly alfalfa, but some waste garden products were also fed.

During the first two years of these tests, embracing four experiments, the dry matter in the grass was estimated and included in the figures for feed eaten; but in the last three tests only the actual weight of grain fed was taken into account. The following table shows a summary of the results:

Value of soiling pigs on grass.

Ration.	Number of tests.	Average daily gain.	Feed eaten daily.	Feed per 100 pounds gain.
Average of all:		*Pounds.*	*Pounds.*	*Pounds.*
Full grain	7	1.04	4.42	424
Full grain and grass	7	1.13	4.74	414
One-fourth grain and grass	3	.36	2.23	659
Average of pens:				
Full grain	4	.94	4.05	442
Full grain and grass	4	1.17	4.75	402

These results show a considerable advantage in daily gains for the pigs that were soiled and a similar saving in feed. The pigs in pens show a very marked advantage for soiling. There was an average daily gain of 0.23 pound more for the soiled pigs than for those on grain alone, and the feed required for 100 pounds gain was nearly 10 per cent less. It is suggested that these good results were due as much to the healthful action of such feed on the digestive system as to their nutrient content.

The Ontario Agricultural College[b] conducted an experiment to compare pasturing on such feeds as vetches and rape with their feeding in pens. Disregarding the item of labor, these results show that soiling is very economical. The average daily consumption of feed by pigs in the pens was approximately 4 pounds of green feed and

[a] Bul. No. 70. See page 93 for explanation of "partial" and "full" grain rations.
[b] An. Rpt., 1901.

$4\frac{1}{3}$ pounds of meal. This experiment was part of a breed test, and generally the best pigs were in the outside lots. Yet the meal required for 100 pounds gain was, for all breeds, 510 pounds with the outside lots and 414 for those in the pens on grain and green feed. At the close of the experiment the pigs were sold, and the packer's report showed nothing unfavorable to the method of feeding. The bacon produced was firm and of good quality in other ways. The pigs that were soiled required twice as much time for attention and feeding as those outside.

Purslane.—Plumb[a] reports a trial in Indiana with two Chester White sows confined in small pens and fed for twenty-one days a mixture of equal parts shorts and hominy meal with all the purslane they would eat. Purslane was not eaten with the relish that was expected, but the pigs made fairly good gains at a cost of 2.2 cents per pound.

Grazing chufas.—Duggar[b] hurdled 9 Berkshire pigs from November 19 to December 17 on chufas, with some grain, and a mixture of corn meal and cowpea meal in addition. They gained 121 pounds, grazed 7,986 square feet of chufas, and ate 262 pounds of grain, thus requiring only 234 pounds of grain for 100 pounds gain. With the usual allowances for the gain due to the grain fed, the return per acre for the chufas, estimating pork at $3\frac{1}{2}$ cents per pound, was $13.09.

Grazing peanuts, chufas, and soy beans.—At the Arkansas Station, Bennett[c] fed four lots of half-bred Berkshire pigs to compare the grazing values of these three crops with pen feeding on corn. The soil on which the crops were grown was a sandy loam with an estimated capacity of 30 bushels of corn per acre. The crops named were planted in rows 3 feet apart—the peanuts 14 inches apart in the rows, the chufas[d] 12 inches apart in the rows, and the soy beans drilled. The stand was estimated at 87 per cent for the peanuts, 75 per cent for the chufas, and only good for the soy beans. The corn was fed dry on the ear, and the grazing was done by using hurdles. The feeding

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[a] Bul. No. 82.

[b] Bul. No. 122, Alabama Expt. Sta.

[c] Bul. No. 54.

[d] Chufas are coarse plants belonging to the sedge family. Two species are used in the manner here mentioned—*Cyperus rotundus* and *C. esculentus*. According to Gray, *C. rotundus* is found in sandy fields from Virginia to Florida and Texas. and is occasionally met with in the neighborhood of Philadelphia and New York City. *C. esculentus* is found in low grounds, along rivers, etc., from New Brunswick to Florida and west to Minnesota and Texas. This is the species more commonly used as feed for hogs.

These plants form small tubers which enable them to spread rapidly and form a thick, matted growth, each tuber being capable of producing a plant. The tubers are relished by hogs, but the plants are of questionable value, as it is almost impossible to eradicate them when once established, especially in sandy soils. Botanists do not advise planting them in soil that can be used for any other purpose.

lasted forty-six days, except for the soy beans, which gave out sooner than expected. The results were as follows:

Peanuts, chufas, and soy beans compared with corn.

Kind of feed.	Number of pigs.	Average weight at beginning.	Total gain.	Average daily gain.
		Pounds.	*Pounds.*	*Pound.*
Peanuts	4	116.5	104.5	0.57
Chufas	4	121.3	66	.35
Soy beans	3	124.75	[a] 22.75	[a] .24
Corn	3	139	112.3	.81

[a] Thirty-two days.

The areas of peanuts and chufas grazed were one-twelfth acre and one-ninth acre, respectively. To produce 112.3 pounds of pork with the corn-fed lot 7.6 bushels of corn were eaten. From these data the yield of pork per acre was estimated as follows:[a] Peanuts, 1,252 pounds; chufas, 592 pounds; corn, 436 pounds, estimating the corn yield at 30 bushels per acre.

The quality of the pork from pigs grazed on chufas and soy beans was about the same as that from corn-fed pigs; the peanut-fed lot produced a soft, oily quality of fat, but no deleterious results could be detected in cooking.

In the following two years Bennett[b] grazed pigs on peanuts and chufas, the results being noted below. In addition to the study of the feeding value of these plants, their effect on the quality of the pork was studied. When hogs are grazed on peanuts or chufas the lard has quite a low melting point; and, as nearly all such feeding is conducted in the Southern States, this condition gives rise to considerable trouble during the summer months. To obviate this difficulty the common practice of farmers is to use corn in finishing hogs that have had peanuts as the principal component of the ration. The results of the study of the effects of these feeds on the quality of pork are presented elsewhere in this bulletin.

Bennett's feeding results in 1899 and 1900 follow:

In 1899 Lot I grazed a crop that was alternately three rows of peanuts and one of chufas; Lot II grazed peanuts; Lot III grazed chufas; Lot IV grazed chufas; Lot V grazed as Lot I. The grazing lasted sixty days, except for Lots IV and V, which grazed ninety days. Lots III, IV, and V had no finishing period on corn. Two pigs were slaughtered in both of the first two lots at the expiration of the grazing period, the melting point of the fat determined, and the remaining pigs put on a full feed of corn. At intervals of two weeks 2 more

[a] Soy beans not estimated. [b] Bul. No. 65, Arkansas Expt. Sta.

pigs were slaughtered and the melting point of the fat determined, continuing in this manner until all the pigs were slaughtered, so that the last pigs to be slaughtered had been on corn eight weeks.

The pigs used in the 1899 experiment were natives, not over one-fourth of improved blood. They were from ten to twenty months old and averaged about 115 pounds in weight.

In 1900 the feeding was as follows: Lot I grazed on a field of alternate rows of peanuts and chufas for seventy-five days, receiving some corn in addition. Lot II grazed a field of alternate rows of peanuts and chufas for fifty days, and for twenty-five days received a quantity of corn equivalent to that fed the above lot. Lot III grazed peanuts for seventy-five days and had corn as Lot I. Lot IV grazed peanuts as above for fifty days and had corn for twenty-five days as the preceding lots. Lot V grazed on peanuts and had corn at the same time for seventy-five days. The pigs of this lot were purebred Berkshires, and were used to determine the effect of improved blood on the melting point of lard.

The quality of these pigs was somewhat higher than in the experiment of 1899. The pigs of Lots I to IV were from eight to twelve months old at the beginning; the purebred pigs were from six to eight months old.

The gains of the pigs, while incidental to the main purpose of the experiment, are of much interest. Those for 1899 are as follows:

Comparative gains in feeding pigs on peanuts, chufas, and corn.

Lot.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.
		Pounds.	*Pounds.*		*Pounds.*
I	10	116.7	981	60	1.63
II	10	116.2	996	60	1.66
III	4	111.5	332	60	1.38
IV	2	115.5	246	90	1.37
V	2	116.5	266	90	1.47

The following gains were made during 1900:

Comparative gains in feeding pigs on peanuts, chufas, and corn.

Lot.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.
		Pounds.	*Pounds.*		*Pounds.*
I	4	99.5	518	75	1.72
II	4	95	482	75	1.60
III	4	96.25	535	75	1.78
IV	4	95	510	75	1.70
V	6	96	717	75	1.59

Grazing peanuts.—At the Alabama Station, Duggar[a] grazed 6 Poland China pigs on peanuts, with some corn in addition. The lot made a

[a] Bul. No. 93.

gain of 380.7 pounds in six weeks on an area of about one-sixth acre and ate 373 pounds of corn. Estimating corn at 40 cents per bushel and pork at 3 cents per pound this is a return of $18.34 per acre for peanuts from this method of feeding, somewhat less than the Arkansas experiment previously mentioned.

On a portion of the field which was not pastured the peanuts were dug and yielded at the rate of 62.6 bushels (1,565 pounds) of dry nuts per acre. From this the total feed required to produce 100 pounds gain was estimated as 140 pounds of peanuts and 190 pounds of corn—a total of 330 pounds of concentrates, with vines eaten not estimated.

Duggar estimates the value of the return from peanuts in pork at $18 per acre, and states that the same land with the same fertilizers, would not produce over 200 pounds of lint cotton per acre, which would be worth $10 or $12, with cotton at 5 or 6 cents per pound, while the expense of cultivating the cotton would be much greater.

In a later experiment Duggar[a] penned a litter of 9-weeks-old pigs on a two-thirds stand of Spanish peanuts just after weaning. They were on this pasture from November 4 to December 23, and ate 162 pounds of corn meal for 100 pounds gain in addition to grazing about five-sixths of an acre of peanuts. At 4 cents per pound for pork, and making allowances for the grain eaten, the return per acre for the peanuts was $10.04.

In another test[a] a sow and her litter of 9 pigs were fed from September 30 to November 4 on corn meal, skim milk, and Spanish peanuts from one-fourth acre of land. They ate 355 pounds of corn meal and 921 pounds of skim milk. The sow and pigs gained a total of 236 pounds. At 4 cents per pound for pork, valuing corn meal at $1 per 100 pounds and skim milk at 25 cents per 100 pounds and estimating 325 pounds of skim milk to be worth 100 pounds corn meal, the return per acre for the peanuts was $17.28.

In another test[a] 7 shoats, averaging nearly 100 pounds, were penned on Spanish peanuts from October 11 to November 2 and fed some corn meal. They made a total gain of 225 pounds, eating 286 pounds of corn meal and grazing the peanuts on 0.47 acre, requiring only 127 pounds of corn meal for 100 pounds gain. With the usual allowances, the return per acre for the peanuts in this test was $18.02.

In another test[a] 7 shoats were taken from corn meal, cowpea meal, and sorghum and placed on Spanish peanuts and corn meal for four weeks. They ate 333 pounds of corn meal and grazed 10,593 square feet of peanuts, making a gain of 121 pounds, which was at a cost of 273 pounds grain for 100 pounds gain. The value per acre of the peanut pasture was estimated, by the usual method, at $9.

Some of these pigs were continued by hurdling on peanut pasture and were given some grain in addition for five weeks longer. In this period the return per acre for the peanuts was estimated at $9.88.

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[a] Bul. No. 122, Alabama Expt. Sta.

In another test[a] a litter of 7 Poland China pigs, averaging 28 pounds in weight, were hurdled on Spanish peanuts just after weaning. The pasturing continued six weeks and no grain was fed. The total gain was 157 pounds, an average daily gain of 0.53 pound. The area grazed was 13,887 square feet, and the return per acre, with pork at 4 cents per pound, was $20.12.

Peanut pasture compared with corn meal.—The Alabama Station[a] fed one lot of pigs on a peanut field which was a poor stand, giving some corn meal additional; another lot had nothing but the peanut pasture, and a third lot corn meal only. There were 3 pigs in each lot, and they were of rather ordinary feeding qualities. In four weeks the lot on peanuts and corn meal gained 38.6 pounds, those on peanuts alone gained 21.1 pounds, and those on corn meal lost 5.1 pounds. The lot on peanuts and corn meal ate 206 pounds of corn per 100 pounds gain and grazed 2,025 square feet planted in peanuts. "This is at the rate of 840 pounds of growth from 1 acre of peanuts (with less than half a stand) and 1,710 pounds (35.6 bushels) of corn meal. With pork at 3 cents per pound and corn meal at 40 cents per bushel of 48 pounds, this is a gross return of $25.20 and a net return (after subtracting the value of the meal) of $10.94 per acre of peanuts."

The pigs on peanuts only "pastured an area of 3,517 square feet, and the gain made was 21.1 pounds, which is at the rate of 261 pounds of pork per acre. At 3 cents per pound gross for pork, this gives a value of $7.83 to the acre of peanuts on which there was only half a stand of plants."

Duggar estimates the value of peanuts in pork production at $12 to $20 per acre, the higher returns being made where corn meal supplements the peanut pasture.

Peanuts and chufas compared with grain.—Duggar[b] fed four lots of 3 pigs each for eighteen days to compare the values of peanut and chufa pasture with grain alone. Lot I grazed Spanish peanuts and had a half ration of a mixture, by weight, of corn meal 2 parts and cowpea meal 1 part; Lot II grazed Spanish peanuts without grain; Lot III grazed chufas, with the same half grain ration as Lot I; Lot IV was fed in a bare lot and given all the mixture fed Lot I that the pigs would eat up clean. The following table shows the results:

Peanut and chufa pasture compared with grain.

Area grazed and ration.	Average weight at beginning.	Number of pigs.	Number of days fed.	Total gain.	Average daily gain.
	Pounds.			*Pounds.*	*Pounds.*
Spanish peanuts grazed, one-half grain ration	121	3	18	81	1.50
Spanish peanuts grazed	85	3	18	22	.41
Chufas grazed, one-half grain ration	106	3	18	79	1.46
Full grain ration	131	3	18	71	1.31

[a] Bul. No. 93, Alabama Expt. Sta.
[b] Bul. No. 122, Alabama Expt. Sta.

Peanut and chufa pasture compared with grain—Continued.

Area grazed and ration.	Total feed eaten. Area grazed.	Grain eaten.	Grain per 100 pounds gain.	Pasturage on 1 acre for a 100-pound shoat.
	Sq. feet.	*Pounds.*	*Pounds.*	*Days.*
Spanish peanuts grazed, one-half grain ration	8,344	152	188	850
Spanish peanuts grazed	12,448			463
Chufas grazed, one-half grain ration	7,937	152	192	827
Full grain ration		304	431	

This experiment shows the best returns when grain was fed with these crops. Grazing peanuts alone was very unsatisfactory. The return per acre of peanuts and chufas, with pork at 4 cents per pound, was estimated, where grain was fed, at $9.56 and $9.62, respectively. The pigs on peanut pasture alone returned only $3.03 per acre for the crop. Those on pasture with grain made much more rapid and economical gains than those on grain only.

The last column of the table is especially interesting. With a small amount of grain it is evident that pasture will be available for a much longer period than when no grain is fed.

Grazing sorghum and cowpeas.—Duggar[a] fed four lots of 3 pigs each for five weeks to compare the value of sorghum and cowpea pasture with a grain ration. Lot I was hurdled on drilled sorghum which was in the dough and ripening stages and received a half grain ration of a mixture, by weight, of corn meal 2 parts and cowpea meal 1 part. Lot II was placed in a pen in which sorghum was growing and had, in addition, enough ripe Spanish peanuts to constitute a half ration of peanuts. Lot III was hurdled on drilled Whip-poor-will cowpeas on which part of the pods were ripe and received no grain. Lot IV was confined in a bare pen and given the grain mixture given Lot I in such amount as the pigs would eat up clean. The following table shows the results:

Grazing pigs on sorghum and cowpeas.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten. Area grazed.	Grain eaten.	Grain per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Sq. feet.*	*Pounds.*	*Pounds.*
Grain Grazed sorghum	3	59	75	35	0.71	4,872	244	328
Spanish peanuts Grazed sorghum	3	59	54	35	.51	4,872		
Grazed ripe cowpeas	3	57	51	35	.48	17,964		
Grain	3	64	124	35	1.18		464	374

[a] Bul. No. 122, Alabama Expt. Sta.

These results are not very satisfactory for grazing on sorghum or on cowpeas without a supplementary grain ration. The waste of feed in the cowpea lot was very great, large numbers of the ripe pease falling to the ground and sprouting. Previous work at the Alabama Station has shown more satisfactory results when grain was fed in conjunction with the cowpea pasture.

Duggar[a] notes another experiment with sorghum grazing, in which there was a large waste of feed, although grain was fed. Seven shoats were on the sorghum from June 24 to September 2, 1899, and received at the same time about $1\frac{1}{2}$ pounds per head daily of a mixture of equal parts, by weight, of cowpea meal and corn meal. The pigs grazed 15,374 square feet of sorghum and 8,380 square feet of second-growth sorghum. They ate 812 pounds of grain, or 360 pounds of grain per 100 pounds of gain. Making allowances for the value of the grain fed, the return per acre of sorghum, with pork at 4 cents per pound, was estimated at $7.80. The second-growth sorghum produced only about one-half as much feed as the first growth. Large quantities of the sorghum were trampled under foot, and when some of it was cut and carried to the pigs a given area lasted much longer than when they were turned in to graze. Duggar suggests that when labor is cheap and abundant or a corn harvester is available soiling sorghum will be the more profitable method of feeding.

Cowpea pasture with corn.—Duggar[b] fed 6 Essex shoats from the same litter to investigate the pasture value of cowpeas. Lot I received corn only. Lot II was hurdled on cowpeas that were about half matured at the beginning of the experiment. The field tested 13.2 bushels per acre of peas, on an unpastured portion. Both lots received hard-wood ashes and salt. The results were as follows:

Cowpea pasture and corn compared with corn alone.

Kind of feed.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Corn eaten.	Corn per 100 pounds gain.
		Pounds.	*Pounds.*		*Pound.*	*Pounds.*	*Pounds.*
Corn alone	3	50.9	45.2	42	0.36	263.8	586
Cowpea pasture and corn	3	49.4	122.0	42	.97	374.0	307

The pigs were pastured on an area of 7,280 square feet, or about one-sixth of an acre. Valuing pork at 3 cents per pound and corn at 40 cents per bushel, the return for cowpeas per acre is $10.65, not including the value of the manure made. By pasturing, 277 pounds of corn were saved per 100 pounds gain, and therefore an acre of cowpeas would replace 1,662 pounds of corn, using this test as a basis.

The Maryland Station[c] fed a number of pigs on cowpea pasture and concluded that cowpeas are well adapted to pigs about three

[a] Bul. No. 122, Alabama Expt. Sta. [b] Bul. No. 93, Alabama Expt. Sta. [c] Bul. No. 63.

months old. The older pigs that had been highly fed and had always been kept in a pen evidently had lost their rustling ability and did not thrive so well on cowpeas.

PUMPKINS AND APPLES.

Feeding pumpkins raw and cooked.—At Ottawa, Grisdale[a] fed pumpkins to pigs in considerable numbers. A field was specially prepared, the seed being planted in hills 8 feet apart each way. The yield was about 9 tons per acre and the cost 90 cents per ton. In feeding one lot received raw pumpkins and grain (a meal mixture of one-half corn meal and one-half a mixture of equal parts of oats, peas, and barley). The other lot received cooked pumpkins and the same meal mixture.

At the Oregon Station, French[b] took 6 Berkshires, eight months old, from a stubble field where they had been for six weeks and placed them on a ration of pumpkins and shorts. The pumpkins were the common yellow field variety, and were prepared by cutting up, removing the seed, and cooking or steaming, after which shorts were mixed with them.

At the New Hampshire Station, Burkett[c] fed pigs to compare cooked and raw pumpkins. Lot I, consisting of 3 pigs, received skim milk, corn meal, and cooked pumpkins; Lot II, consisting of 3 pigs, received milk, corn meal, and raw pumpkins. The following table shows the result of these experiments:

Value of pumpkins as feed for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.			Cost per 100 lbs. gain.
						Grain.	Milk.	Pumpkins.	Grain.	Milk.	Pumpkins.	
Ottawa:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Raw pumpkins	----	-------	745	107	------	1,981	------	2,090	267	------	281	3.08
Cooked pumpkins	----	-------	706	99	------	1,602	------	7,500	227	------	1,062	2.96
Oregon:												
Cooked pumpkins	6	171.5	499	-----	1.49	924	------	7,523	185	------	1,508	2.99
New Hampshire:												
Raw pumpkins	3	142	170	25	2.26	514	630	1,348	302	370	793	3.31
Cooked pumpkins	3	138.6	166	25	2.21	514	630	742	309	379	447	3.32

Averaging these results, the raw pumpkins rations show 273 pounds of grain and 376 pounds of pumpkins for each 100 pounds of gain, and the cooked pumpkins rations, 222 pounds of grain and 1,150 pounds of pumpkins for each 100 pounds of gain.

[a] An. Rpt., 1900, Central Experimental Farm. [b] Bul. No. 54. [c] Bul. No. 66.

Raw pumpkins alone.—Burkett[a] fed one lot of hogs on a ration of uncooked pumpkins with no other feed but skim milk with the following results:

Pigs ....number..	3	Pumpkins ....pounds..	3,798
Average weight at beginning ....pounds..	141	Milk per 100 pounds gain ..do....	750
Total gain ....do....	84	Pumpkins per 100 pounds gain ....pounds..	4,520
Days fed ....number..	25	Cost of feed per 100 pounds gain ....dollars..	2.39
Average daily gain ....pounds..	1.12		
Milk consumed ....do....	630		

Feeding pumpkins and apples.—At the same time with the test outlined in the preceding paragraph, Burkett fed a lot of 3 pigs on a ration of apples and pumpkins, half and half, cooked. The pumpkins in all the New Hampshire experiments were raised at a cost of 40 cents per ton; the apples were common cider apples, or windfalls, and were valued at 10 cents per bushel.[b] The results are as follows:

Pigs ....number..	3	Pumpkins and apples ..pounds..	3,762
Average weight at beginning, pounds	140	Milk per 100 pounds gain .do....	545
Total gain ....pounds..	116	Pumpkins and apples 100 pounds gain ....pounds..	3,246
Days fed ....number..	25	Cost of feed 100 pounds gain. dollars	4.65
Average daily gain .....pounds..	1.54		
Milk consumed ....do....	630		

The higher cost of gain in this test is attributed to the apples, and it is questioned whether it pays to feed them at a cost equal to or exceeding 10 cents per bushel.

ROOTS AND TUBERS.

Feeding roots to live stock is comparatively recent in the United States. Corn, with hay and ensilage, has been the principal maintenance during the winter months when pasture was not available. In hog feeding it is safe to say that, until very recent years, almost the only substitutes for pasture were pumpkins, artichokes, and clover or alfalfa hay in certain sections. In England and Canada, however, much dependence is placed on roots, and, while we may never reach the point in this country generally of fattening animals almost entirely on a root diet, the peculiar advantages to be gained by them, their great palatability, and the good effect on the health and thrift of the animal commend roots to the stockman.

A number of experiments have been reported recently on feeding roots to hogs.

At the Indiana Station, Plumb and Van Norman[c] conducted two experiments to compare a ration composed solely of grain with one

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[a] Bul. No. 66, New Hampshire Expt. Sta.

[b] New Hampshire has no legal weight per bushel for apples, and this bulletin did not state the weight used. The legal weight in other States varies from 44 to 50 pounds.

[c] Buls. Nos. 79 and 82.

where roots were added. In both experiments the grain ration was 1 part corn meal, 2 parts shorts, fed as slop. No drink other than water was given. In the first experiment mangels were fed; in the second the roots were sugar beets sliced and fed in the slop, and they were relished more than the mangels.

At the Ontario Agricultural College, Day[a] fed four lots of pigs in pens as follows:

Lots I and II were made up of 4 grade Yorkshire pigs each from the same litter, about seven weeks old; Lots III and IV contained 5 grade Yorkshire pigs each from the same litter, about 9 weeks old. Lot I received barley and middlings; Lot II received barley and middlings with an equal weight of raw pulped mangels; Lot III received corn and middlings; Lot IV received corn and middlings with an equal weight of raw pulped mangels. The proportion of grain to middlings was 1:2 in all lots at the beginning of the experiment, and was gradually changed as the pigs increased in weight and age until it was 2:1 toward the close.

At the Utah Station, Foster and Merrill[b] conducted two experiments to compare a ration of bran and sugar beets with rations of corn meal, ground wheat, and corn meal and peas. In the first experiment Lot I received corn meal, Lot II received ground wheat, and Lot III received sugar beets with a one-third ration of bran. In the second experiment Lot I received a mixture of equal parts of corn meal and ground peas, Lots II and III being fed as in the first test. The pigs were fed in covered pens, and were given all they would eat. There were 3 in each lot.

At the Montana Station, Shaw[c] fed one lot of hogs on grain only and another on the same grain ration with sugar beets added. The following table shows the results of these experiments:

Value of roots as feed for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten. Grain.	Total feed eaten. Roots.	Feed per 100 pounds gain. Grain-fed lots.	Feed per 100 pounds gain. Grain-and-root fed lots. Grain.	Feed per 100 pounds gain. Grain-and-root fed lots. Roots.
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Indiana:										
Grain	6	46	443	77	0.96	1,643		371		
Grain and roots	6	44	356	77	.77	1,320	514		371	145
Grain	4	60	444	98	1.13	1,697		382		
Grain and roots	4	60	382	98	.77	1,186	1,568		310	410
Ontario Agricultural College:[d]										
Grain	4	42	501	196	.64			439		
Grain and roots	4	42	672	196	.86				380	
Grain	5	55	664	196	.68			455		
Grain and roots	5	55	744	196	.76				404	

[a] An. Rpt., 1901.
[b] Bul. No. 70.
[c] Bul. No. 27.
[d] The grain per 100 pounds gain in the Ontario results is dry matter.

Value of roots as feed for pigs—Continued.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Total feed eaten.		Feed per 100 pounds gain.		
						Grain.	Roots.	Grain-fed lots.	Grain-and-root fed lots.	
									Grain.	Roots.
Utah:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Corn meal	3	97	229	91	.85	1,279		558		
Ground wheat	3	97	324	91	1.2	1,505		464		
Bran and roots	3	97	167	91	.62	471	2,761		282	1,653
Corn meal and pease	3	87	410	122	1.12	1,672		407		
Ground wheat	3	86	330	122	.90	1,330		403		
Bran and roots	3	89	258	122	.70	880	[a]1,771		341	686
Montana:										
Grain	7	111	557	66	1.20	2,967		532		
Grain and roots	7	115	576	66	1.26	2,497	819		426	142
Average								442	359	427

[a] Includes 111 pounds of potatoes.

In the experiments tabulated here roots were fed in seven tests to 32 pigs, and in comparison grain was fed in nine tests to 38 pigs, making a total of sixteen lots and 70 pigs. In six of the seven tests where roots were fed there was a saving of grain. In one instance (in Indiana) nothing was gained by feeding roots. The average of feed per 100 pounds gain shows that feeding 427 pounds of roots saved 83 pounds of grain, or 19 per cent, which is a very high value for roots.

This feature of root feeding has previously been remarked upon in this bulletin. Attention is called to it in nearly every instance where experimenters have fed roots successfully. Plumb and Van Norman [a] do not regard their results as showing great value for roots, but think that they have an effect on the appetite, digestion, and general health that is beneficial, particularly in winter. In the Ontario [b] experiments the equivalent for 100 pounds of meal was 319 pounds of roots in the first and 564 pounds in the second. Day calls attention to the fact that both figures are very high values for roots, and points out that, "according to analyses and digestion experiments, there is approximately about nine times as much digestible matter in a mixture of corn and middlings as there is in mangels. It is difficult to explain, therefore, how 564 pounds of mangels should prove equal to 100 pounds of meal." The pigs receiving mangels showed the effects of their feed in more growth and thrift than the others. They had less tendency to become fat, and the root ration was reduced for this reason. Day [b] explains this effect of root feeding to be due to a "beneficial effect on the digestive organs of the animals, causing them to digest their food better than did the others; for there is little doubt that hogs closely confined in pens are likely to suffer from indigestion." Shaw [c] explains the marked effect of roots in similar

[a] Bul. No. 79, Indiana Expt. Sta.

[b] An. Rpt., 1901, Ontario Agricultural College.

[c] Bul. No. 27, Montana Expt. Sta.

words, stating that the value for sugar beets for pigs is "derived not so much from the nutrients in the dry matter which they contain as from the influence they exert on digestion and assimilation." This action of roots in the ration is undoubtedly similar to what has already been noted in the case of dairy by-products and pasture. The improvement that roots bring about in the condition of the digestive system must also affect indirectly the entire system and thus promote the general health.

Henry found the results at three American stations to be that about 615 pounds of roots saved 100 pounds of grain. The Danish experiments give 600 to 800 pounds of mangels and from 400 to 800 pounds of fodder beets as the feeding equivalent of 100 pounds of grain.[a]

The average of the results here given indicates that about 515 pounds of roots saved 100 pounds of meal, a somewhat higher value for roots than that given in previously published work.

An experiment conducted by Shaw[b] at the Montana Station, the results of which were published since the foregoing figures were compiled, showed an average daily gain for pigs of 1.58 pounds, at a cost of $4.60 per 100 pounds gain on grain only (9.11 pounds of grain per head daily); a second lot, on grain and sugar beets (6.65 pounds grain and 4.58 pounds sugar beets per head daily) made an average daily gain of 1.64 pounds, at a cost of $3.80 per 100 pounds. There were 4 pigs in each lot and they were fed 50 days. As a sidelight on the possibilities of pork production in the irrigated Northwest, it is interesting to note that Shaw found his net profit from feeding these 8 pigs to be $14.12, "or 33 per cent on the investment in fifty days."

Comparing various roots.—At the Central Experimental Farm in Canada, Grisdale[c] fed four lots of pigs to compare the feeding value of turnips, mangels, and sugar beets. In each case the meal mixture fed consisted of one-half corn, the other half being equal parts of oats, pease, and barley. In addition each pig was given 3 pounds of milk daily and all the roots he would consume. The roots were fed as follows: Lot I, turnips fed pulped; Lot II, mangels fed pulped; Lot III, sugar beets grown for forage, fed pulped; Lot IV, sugar beets grown for sugar production, fed pulped. The results were as follows:

Value of various roots for pigs.

Ration.	Number of pigs.	Average weight January 7.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.		
						Meal.	Roots.	Milk.	Meal.	Roots.	Milk.
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Lot I, turnips	4	101.25	363	106	0.85	780	3,808	1,284	215	1,049	354
Lot II, mangels	4	96.75	389	106	.90	786	5,930	1,284	202	1,524	330
Lot III, forage beets	4	76.75	500	106	1.18	793	4,298	1,284	159	860	257
Lot IV, sugar beets	4	57.00	[d]528	138	.95	1,032	4,266	1,680	195	808	318

[a] Feeds and Feeding, pp. 570, 571.
[b] Bul. No. 37.
[c] An. Rpt., 1901.
[d] Feeding ceased May 25.

On Lots I and II no deleterious results are mentioned in either buyers' or packers' reports. On Lot III the buyer reported 3 "select" and 1 "fat," and the packers' report was not so favorable to this lot as to Lots I and II. On Lot IV the buyer reported all "select;" there was no packer's report on carcasses of this lot.

In this experiment the pigs on forage beets made the greatest average daily gains and required the least feed for 100 pounds gain, the other lots standing in the order of sugar beets, mangels, and turnips. The results are remarkably low in feed requirements and would seem to show that roots and milk may be more advantageously combined than pasture and milk.

Day at Guelph and Shutt at Ottawa have found that the effect of roots on the carcass is not detrimental, but produces a firm bacon of good quality—a very essential matter to Canadian pig feeders. In this experiment neither buyers nor packers criticised adversely the pigs fed on turnips and mangels, and the carcasses of the sugar-beet pigs were all "select" (there was no packer's report on this lot); but the buyer found one carcass too fat in the lot fed on forage beets, and the packer's report was not so favorable as on the others.

Sugar beets alone.—At the Colorado Station, Buffum and Griffith[a] fed 4 pigs on sugar beets alone. There was some difficulty at first in inducing the pigs to eat beets, but after they had become accustomed to such a diet they took to it readily. At no time were the pigs able to eat beets enough to approach the conventional feeding standards; 12.50 pounds daily was the greatest amount they would take. For a brief period at the close (two weeks) forage beets were fed, the supply of sugar beets giving out. The results were as follows:

Average weight at beginning	pounds	100
Total gain	do	67
Days fed		99
Average daily gain	pound	.17
Average amount of feed eaten	do	1.027
Feed per 100 pounds gain	do	6.130
Cost per 100 pounds gain	dollars	12.30
Average profit with pork at 7 cents per pound	cent	.13
Dressed weight	per cent	77

Sugar beets alone are thus seen to be only a very expensive maintenance ration.

A comparison of sugar-beet pulp and sugar beets.—In Colorado, Buffum and Griffith[a] fed one lot of pigs on a ration of sugar-beet pulp and equal parts of wheat and barley; another on the same ration, except that sugar beets were fed instead of pulp; the results with a third lot, on equal parts of wheat and barley, are compiled in the table below as a check.

[a] Bul. No. 74.

The pulp cost, laid down at the college, $1 per ton. It was piled on well-drained ground and kept well without an undue amount of fermentation. The beets fed were grown on the college farm. Their cost was estimated at $4 per ton. During the last two weeks of the experiment the supply ran out and forage beets were substituted for sugar beets. The change is not thought to have influenced results.

There was some difficulty in inducing the pigs to eat the pulp, but the sugar beets were eaten from the start, although they were apparently not relished at first. The following table shows the results:

Sugar-beet pulp compared with sugar beets.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.			Feed per 100 pounds gain.			Cost per 100 pounds gain.	Average profit at 7 cents per pound.
						Grain.	Pulp.	Beets.	Grain.	Pulp.	Beets.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Grain	4	95	120	104	1.16	546.50			450			4.50	3.90
Beet pulp and grain	4	97	88	99	.89	343	706		390	800		4.30	3.35
Sugar beets and grain	4	101	98	104	.94	416		391	420		400	5.00	2.93

Potatoes.—Clinton[a] reports an unsuccessful attempt at Cornell to feed potatoes raw and cooked. Some grain and skim milk were given in addition, but, while over 400 pounds of potatoes were eaten, the pigs made no progress and were getting out of condition when the experiment was brought to a close. The low temperature while the pigs were being fed, ranging between 29° and 30° F., is suggested as a reason for the poor results.

At the Central Experimental Farm[b] very satisfactory results were obtained from cooked potatoes, but raw potatoes produced little gain. In one experiment the pigs were given all the raw potatoes they would eat, but made no gain and the tubers were discontinued. In a second test a similar experience led to a change to cooked potatoes. The opinion of investigators at this station is that raw potatoes are of little value for feeding pigs, but when cooked they are worth about one-fourth as much as mixed grain.

The following table shows the results of three tests where cooked potatoes were fed with success. The meal fed was a mixture of equal

[a] Bul. No. 199, Cornell University Expt. Sta.
[b] Bul. No. 33.

parts by weight of ground barley, ground rye, ground frozen wheat, and bran:

Cooked potatoes for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average weight at close.	Average net gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.			Feed per 100 pounds gain.		
							Meal.	Potatoes.	Milk.	Meal.	Potatoes.	Milk.
		Lbs.	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Potatoes (cooked), meal (soaked), skim milk	3	56	171	115	140	0.82	177	831	315	152	718	272
Potatoes (cooked), meal, skim milk	3	55	195	140	140	1.00	289	712	105	205	506	74
Potatoes (cooked), meal, skim milk	3	50	192	142	140	1.01	140	1,034	420	98	729	296

Sweet potatoes.—The Alabama, South Carolina, Maryland, and Florida stations have experimented with sweet potatoes with somewhat varying results.

At the Alabama Station, Duggar[a] fed one lot of pigs on a ration of three-fourths sweet potatoes and one-fourth ground cowpeas and another on a ration of equal parts of corn meal and cowpeas. After four weeks they were put through an intermediate period of one week and the rations were reversed, the lot that had formerly been on corn meal and cowpeas receiving the sweet potato ration. This was continued for four weeks longer, so that in all there were eight weeks' feeding on a sweet potato ration.

The ration of sweet potatoes and cowpeas proved very inferior to the ration of corn meal and cowpeas; the increase in live weight was nearly twice as great in the case of corn meal and cowpeas, and the dry matter per 100 pounds of gain was estimated at 600 pounds where sweet potatoes were fed to 360 pounds where corn meal was fed. Duggar refers to the difficulty of inducing the pigs to eat enough dry matter when sweet potatoes made up so much of the ration, and suggests a ration of equal parts of cowpeas and sweet potatoes as being more palatable and nutritious. He questions whether sweet potatoes can be profitably grown, stored, and fed to hogs unless the feeding value per bushel would be more than 10 or 15 cents. Where the pigs do the harvesting, especially on sandy soils, where the yield of sweet potatoes is ten or fifteen times that of corn, they may be an economical feed.

The results at the South Carolina Station were much more favorable to sweet potatoes. Newman and Pickett[b] fed a lot of 3 pigs, averaging 162 pounds in weight, on sweet potatoes only for forty-three days, beginning November 23. At the same time corn was fed to 3 pigs, averaging 156 pounds in weight. Two pigs in each lot were high-grade Berkshires and the third was a grade Duroc Jersey.

[a] Bul. No. 93. [b] Bul. No. 52.

The pigs on sweet potatoes ate 26.2 pounds per head daily and made an average daily gain of 0.86 pound. They ate 3,247 pounds of sweet potatoes for 100 pounds of gain.

The pigs on corn ate an average of 9.2 pounds of grain daily, and made an average daily gain of 1.39 pounds, requiring 602 pounds of corn for 100 pounds of gain.

It was estimated that, at 200 bushels per acre, sweet potatoes would produce 369.5 pounds of pork per acre, worth $18.47 when pork is worth 5 cents per pound. The gain from corn was 139.5 pounds of pork, and the corn yield was 15 bushels per acre on land similar to that on which the sweet potatoes were grown. At 5 cents per pound for pork, the money return for the corn was $6.97 per acre.

The Maryland Station[a] reports an attempt to maintain pigs exclusively on sweet potatoes. A lot of rather mature pigs was put on a ration of small sweet potatoes and "strings" that were fed raw twice a day for thirty-one days. It required over 5 tons of these potatoes for 100 pounds of gain, and the return from them was only about $1.60 per ton.

The value of this feed when given with grain was tested with a younger lot of pigs for thirty days. With this lot, 593 pounds of sweet potatoes, 277 pounds of milk, and about 60 pounds of grain were required for 100 pounds of gain, and the value per ton of the potatoes was estimated at $2.40, showing sweet potatoes to be more valuable when fed with grain and milk.

The Florida Station[b] fed a lot of 4 native hogs on a ration of equal parts by weight of sweet potatoes and wheat middlings, the ration being 3.5 pounds of each per 100 pounds live weight of hog. They were confined in an open pen and fed twice daily. The hogs averaged 101.5 pounds at the beginning of the test and increased in weight 31.16 per cent, or 126.5 pounds, at a cost of 5.6 cents per pound of gain for feed eaten.

At the Alabama Station, Duggar[c] penned 2 shoats, averaging 116 pounds, on sweet potatoes for thirty-five days. They were given, in addition, 2 pounds of ground corn and 1 pound of ground cowpeas per head daily. In the time specified they gained 67 pounds, an average daily gain of 0.93 pound, thus requiring 313 pounds of grain in addition to the sweet potatoes for each 100 pounds gain. Duggar states that the sweet potatoes were not relished greatly and that there was much waste of them, due probably to the relatively large amount of grain fed.

Artichokes.—At the Oregon Station[d] French took 6 Berkshire pigs from wheat stubble on October 22 and placed them on a field of artichokes that had been planted in April on deep-plowed ground, prepared, as for potatoes, in rows 3 feet apart, with the seed 18 inches apart in the row. The growth was vigorous and the yield abundant, the tops growing to a height of 7 feet during the season,

[a] Bul. No. 63. [b] Bul. No. 55. [c] Bul. No. 122. [d] Bul. No. 54.

and a trial plot showing a yield of 740 bushels per acre. The pigs had free access to the field and did all the harvesting. An attempt to sustain them entirely on the tubers failing, some shorts were fed in addition.

At Ottawa, Grisdale[a] sowed a plot of one-sixteenth acre with about 70 pounds of tubers on May 19, planting in rows 24 inches apart, 4 inches deep, and 20 inches apart in the rows. Six pigs were turned in October 3. Although the tubers were immature at that time, the tops were from 10 to 13 feet high. The pigs were allowed a daily grain ration of 1.5 pounds of a mixture composed of one-half corn meal and one-half of a mixture of equal parts of ground oats, pease, and barley.

In both experiments the Jerusalem artichoke (*Helianthus tuberosus*) was used. The following table shows the results:

Artichokes as feed for pigs.

Station.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Grain fed.	Grain per 100 pounds gain.	Cost of grain per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*	*Dollars.*
Oregon	6	162.6	244	50	0.81	756	309	1.85
Ottawa	6	104.6	197	21	1.57	189	96	1.80
Average							202.5	1.825

The cost of the meal in the Oregon experiment was estimated at $12 per ton; that in the Canadian one at $18 per ton. Valuing the meat made at $6.25 per 100 pounds, Grisdale estimates that, after deducting the cost of the meal fed, a balance of $10.61 is left for the artichokes fed, and deducting from this the cost of seed, planting, rent of land, etc., the one-sixteenth acre used gave a net return of pork worth $8.76.

ROUGHAGE.

Hogs are generally regarded as animals whose peculiar function is the conversion of concentrated feed into meat. Although the capacity for bulky feed that we find in the stomachs of cattle and sheep is lacking in hogs, a reasonable amount of bulk in the form of roots or hay is palatable and profitable. In many parts of the country, where concentrates are costly feeds, stockmen are forced to use substitutes for at least a part of the grain ration, both for fattening and maintenance, and over the entire country the winter ration is a problem. To solve these problems many western farmers have resorted to the use of alfalfa hay, and outside alfalfa districts clover hay is used. Considerable study has been devoted to this subject by the experiment stations.

Alfalfa hay.—The Kansas Experiment Station[b] has reported a series of experiments with drouth-resistant crops. Three of these

[a] An. Rpt. 1900, Central Experimental Farm.

[b] Bul. No. 95.

experiments had to do with alfalfa hay. In the first, the hogs used were of mixed breeding—Berkshire and Poland China—representing about the average of Kansas farm hogs. The alfalfa was of good quality.

Two lots were fed—one receiving the hay whole in greater quantity than it would consume, the other having ground hay. In the second test the meal-fed lot received some cotton-seed meal—0.16 pound to each pound of Kafir corn, which did not affect the hogs seriously. This test was conducted during the most severe weather of the winter, the thermometer registering 32° F. below zero February 12, ten days after the experiment began.

In the third test the grain was wet with water at the time of feeding. The alfalfa hay had been cut late and was rather woody.

The Utah Station [a] fed one lot of hogs on a mixture of equal parts by weight of chopped wheat and bran, wet. Another lot had the same grain ration with chopped alfalfa hay added. "The alfalfa used was well cured and was prepared by running through an ensilage cutter, the blades of which are arranged for cutting into half-inch lengths." The pigs were thrifty grade Berkshires.

The Montana Station [b] fed three lots of hogs to compare the feeding values of a grain ration with sugar beets and alfalfa hay as roughage with a ration of grain only. The results of the lots that were fed on grain alone and on grain and alfalfa hay are presented herewith. The lot on grain alone received a ration consisting, during the early part of the experiment, of 2 parts of damaged wheat and 1 part oats, barley taking the place of the wheat during the latter part of the experiment. The hay-fed lot had the same ration with alfalfa hay added. The alfalfa hay was run through a cutting box, moistened, and mixed with meal. The hogs were by a Berkshire boar out of high-grade Poland China sows. They had previously had the run of a stubble field, with some clover pasture.

The following table shows the results of these experiments:

Value of roughage for pigs.

Ration.	No. of pigs.	Average weight at beginning.	Total gain.	No. of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.	
						Grain.	Hay.	Grain.	Hay.
Kansas:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Kafir corn meal, dry	10	126	524	63	0.83	3,925	------	749	------
Kafir corn meal, dry, and whole alfalfa hay	10	127	909	63	1.44	4,679	659	515	72.4
Kafir corn meal, dry, and ground alfalfa hay	10	127	833	63	1.32	4,479	656	538	78.7
Kafir corn meal, and cotton-seed meal, wet	6	161	126	22	.95	681	------	540	------
Kafir corn meal, wet, and whole alfalfa hay	6	164	117	22	.88	629	251	538	214

[a] Bul. No. 70. [b] Bul. No. 27.

Value of roughage for pigs—Continued.

Ration.	No. of pigs.	Average weight at beginning.	Total gain.	No. of days fed.	Average daily gain.	Feed eaten.		Feed per 100 pounds gain.	
						Grain.	Hay.	Grain.	Hay.
Kansas—Continued.		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Kafir corn, whole	10	138	456	50	.91	2,910	......	640	.....
Kafir corn meal	10	139	441	50	.88	2,872	......	653	.....
Kafir corn, whole, and alfalfa hay	10	142	685	50	1.37	3,434	898	501	131
Kafir corn meal and alfalfa hay	10	140	686	50	1.37	3,535	844	516	123
Utah:									
Chopped wheat and bran	4	58	689	135	1.28	3,196	......	464	......
Chopped wheat and bran and chopped alfalfa hay	4	58	647	135	1.19	2,942	270	455	41.7
Montana:									
Grain only	7	111	557	66	1.20	2,967	......	532	......
Grain and alfalfa hay	7	111	552	66	1.19	2,683	370	486	67
Average:									
For lots fed grain only	......	....	....	......	....	....	......	593	......
For lots fed hay	......	....	....	......	....	....	......	505	89

The feeding value of alfalfa hay, as indicated in the foregoing tables, does not in the least warrant a claim that it can be used economically as the sole ration. In all but two instances a considerable saving of feed was found to be effected by its use, but the statement that its feeding value is almost equal to that of corn is true only within certain limits. Where hogs are confined to an exclusive grain ration, and especially where this is made up of a single grain, the addition of a moderate amount of hay to the ration will be relished and less grain will be required. At the same time, better and cheaper gains are usually made by hogs so fed than by those on grain alone, but the value of the grain saved is out of all proportion to the value of the hay fed, and the hay in the ration can not be used economically in more than very moderate amounts. This is a similar fact to that which has been found by many investigators with such bulky feeds as green clover, rape, roots, and skim milk. That it is bad economy to attempt the maintenance of hogs on alfalfa hay alone is shown by the experiment noted below by McDowell in Nevada.

A consideration of the approximate proportions of hay to grain fed in these experiments is of interest. The greatest proportion of hay to grain was fed at the Kansas Station and the ratio was 1:2.5. With this ratio the least daily gain was made. The gains were the most expensive of any of the lots, and no advantage accrued from the use of hay. The least proportion of hay (1:11) was fed at Utah and gave the most economical gains. The greatest daily gain and the greatest amount of grain saved was in a Kansas lot fed whole alfalfa hay and

dry Kafir corn meal in the proportion of 1:7. The following table shows the effect of these rations in greater detail. The best results seem to come from the use of hay in the proportion of from one-seventh to one-fourth of the ration when hay makes up all the roughage:

Ratio of hay to grain in feeding hogs.

Ratio of hay to grain.	Average daily gain.	Feed per 100 pounds gain.		Grain saved.
		Grain.	Hay.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Kansas:				
1:2.5	0.88	538	214	1.8
1:4	1.37	501	131	139
1:4	1.37	516	123	137
1:7	1.44	515	72.4	234
1:7	1.32	538	78.7	211
Montana:				
1:7	1.19	486	67	46
Utah:				
1:11	1.19	455	41.7	9

Feeding alfalfa hay alone.—There is very little experimental work on this phase of the subject. The opinions of experimenters and of stockmen generally seem to be that whenever hay alone is resorted to it is no better than a maintenance ration. In the alfalfa-growing districts hogs are frequently run through the winter at the haystacks owing to the scarcity and expense of a grain ration. At the Nevada Station, McDowell[a] fed two lots of 2 pigs each on a ration of alfalfa hay. The two lots ate in twenty-one days 99.12 pounds and 99.14 pounds, respectively, and lost in weight 33.25 pounds and 51 pounds, respectively, an average daily loss of 0.79 pound and 1.21 pounds, respectively. "While feeding hay alone the pigs spent much time curled up in the bedding, but when about the stalls were restless, and even in eating it was done in a ravenous way unlike that of a hearty, well-fed pig." After the hay-feeding period both lots were given grain and roots and made satisfactory gains.

Sugar beets compared with alfalfa hay.—The Utah Station[b] conducted three experiments, which give valuable data on the relative feeding value of sugar beets and alfalfa as winter roughage. In the first experiment Lot I had all the alfalfa hay they would eat and 2 pounds of corn meal per head daily. Lot II received all the beets they would eat and 2 pounds of bran per head daily.

In the second experiment Lot I had all the alfalfa hay they would eat and 2 pounds of bran per head daily; Lot II had all the alfalfa hay they would eat and 3 pounds of bran per head daily; Lot III had all the sugar beets they would eat and 2 pounds of bran per head

[a] Bul. No. 40.

[b] Bul. No. 70.

daily; Lot IV had all the sugar beets they would eat and 3 pounds of bran per head daily.

In the third experiment Lot I had all the alfalfa hay they would eat and 2 pounds of a grain mixture of equal parts by weight of bran and chopped frozen wheat per head daily; Lot II was fed all the alfalfa hay they would eat and 3 pounds of the same grain mixture as Lot I per head daily; Lot III had all the sugar beets they would eat and the same grain ration as Lot I; Lot IV was fed all the sugar beets they would eat and the same grain ration as Lot II.

The Montana Station[a] fed one lot of 7 pigs on a grain ration consisting of 2 parts of damaged (frosted) wheat and 1 part oats, with raw sugar beets; another lot of 7 pigs had the same grain mixture, with chopped alfalfa hay. Barley replaced the wheat during the latter part of the experiment.

The following table combines the results of these experiments:

Alfalfa hay compared with sugar beets for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Total gain.	Number of days fed.	Average daily gain.	Feed eaten.			Feed per 100 pounds gain.		
						Grain.	Hay.	Beets.	Grain.	Hay.	Beets.
Utah:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Alfalfa and corn meal	3	102	195	75	0.86	751	372	------	385	191	------
Sugar beets and bran	3	96	174	75	.77	[b]719	------	1,109	414	------	637
Alfalfa and 2 pounds bran per head daily	3	98	77	54	.47	315	242	------	407	312	------
Alfalfa and 3 pounds bran per head daily	3	102	85	54	.52	472	145	------	553	170	------
Sugar beets and 2 pounds bran per head daily	3	103	121	54	.75	315	------	1,870	251	------	1,541
Sugar beets and 3 pounds bran per head daily	3	102	155	54	.95	473	------	1,270	305	------	821
Alfalfa and 2 pounds grain per head daily	5	58	211	71	.59	700	388	------	332	136	------
Alfalfa and 3 pounds grain per head daily	5	61	292	71	.82	1,050	219	------	359	75	------
Sugar beets and 2 pounds grain per head daily	5	61	282	71	.79	700	------	3,024	247	------	1,072
Sugar beets and 3 pounds grain per head daily	4	92	301	71	1.06	1,050	------	1,843	348	------	611
Montana:											
Alfalfa and grain	7	111	552	66	1.19	2,683	370	------	486	67	------
Sugar beets and grain	7	114	576	66	1.26	2,497	------	819	426	------	142
Average, alfalfa	----	--------	------	----	------	--------	------	-------	423	123	------
Average, sugar beets	----	--------	------	----	------	--------	------	-------	358	------	617

[a] Bul. No. 27.

[b] Includes 235 pounds of corn meal.

This table shows an average for pigs fed on grain and alfalfa of 423 pounds of grain and 123 pounds of hay per 100 pounds of gain, and an average for pigs fed on grain and sugar beets of 358 pounds of grain and 617 pounds of beets—a difference of 65 pounds of grain, or over 15 per cent in favor of sugar beets.

Alfalfa hay and sugar beets in a grain ration.—Since the foregoing results were compiled the Colorado Station[a] has reported results unfavorable to either hay or sugar-beet feeding. Nine Berkshire pigs, averaging about 150 pounds, were fed. Lot I received a mixture of approximately 2 parts barley and 1 part corn, and about one-half pound alfalfa hay daily; Lot II had the grain ration only; Lot III had the grain ration and about 1 pound of sugar beets daily. There was some difficulty at first to get the pigs in Lot I to eat alfalfa, but when it was cut fine and mixed with barley slop they would take it. The results were as follows:

Alfalfa hay compared with sugar beets for pigs.

Ration.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Average amount feed eaten.				Feed per 100 pounds gain.			Cost per 100 pounds gain.	Average profit, pork at 5 cents per pound.
						Corn.	Barley.	Hay.	Beets.	Grain.	Hay.	Beets.		
		Lbs.	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Grain and alfalfa hay	3	162	101	97	1.13	410	191	55	-------	544	49	-----	4.90	1.73
Grain only	3	155	105	97	1.08	381	174	-----	-------	528	-----	-----	4.60	1.94
Grain and sugar beets	3	148	96	97	.99	350	184	-----	99	555	-----	103	5.20	1.26

In this experiment neither the feeding of beets nor hay gave economical results. Grain feeding was cheaper than either, although the gains from grain and hay were somewhat larger than those from the pigs on grain only. The proportion of hay to grain fed in this experiment was approximately 1:11; that of beets to grain was a little wider than 1:5.

Corn fodder.—The Maryland Station has conducted a number of experiments with ground corn fodder, or "new corn product," as it is otherwise called. This product is the ground residue of cornstalks from which the pith has been removed. It was fed to pigs varying in age at the beginning from eight to twelve weeks. All rations contained milk, and the fodder was fed in different proportions to note any possibly advantageous results from such a practice. No special advantages could be observed from feeding the corn fodder, either in

[a] Bul. No. 74.

lessening the amount of grain required for 100 pounds of gain or in lowering the cost, except after the pigs were six months old. For fairly mature pigs the "new corn product" probably would have an effect in a ration somewhat similar to that of alfalfa hay.

BREED TESTS.

INFLUENCE OF BREED ON FEEDING POWERS.

In the foregoing pages attention has been called to the fact that there is very little difference in the standards of excellence for the various breeds of what has come to be designated the "lard," "fat," "block," or "corn-belt" hog. Tests of the different breeds made in different parts of the country show that, with standards that are similar to a large extent, there is very little difference in the cost of pork production by the best representatives of any of the established breeds. Indeed, these experiments show rather more, for they indicate that the breeds of the bacon type rank well in economy of gain with those of the "corn-belt" lard type. Curtiss and Craig[a] quote Hayward of the Pennsylvania Station to the effect that the results obtained in Maine, Massachusetts, and Ontario show the feed eaten per 100 pounds gain by various breeds to be as follows: Poland China, 407 pounds; Berkshire, 419 pounds; Tamworth, 420 pounds; Chester White, 500 pounds; Duroc Jersey, 522 pounds. The writer has averaged results for six leading breeds obtained by various experiment stations when there were a sufficient number of tests and a total number of pigs large enough to make the averages thoroughly representative. The stations whose figures were used are Maine, Vermont, New York State, Michigan, Wisconsin, and Iowa, in the United States, and the Ontario Agricultural College and the Central Experimental Farm, in Canada. The following table shows a variation in feed per 100 pounds of gain from 344 to 418 pounds:

Feed required for 100 pounds gain by different breeds.

Breed.	Number of tests.	Number of pigs.	Feed per 100 pounds gain.
			Pounds.
Tamworth	16	92	344
Chester White	13	71	347
Poland China	22	96	357
Berkshire	23	121	369
Large Yorkshire	11	67	407
Duroc Jersey	11	66	418

[a] Bul. No. 48, p. 444, Iowa Expt. Sta.

Iowa experiments.—Curtiss and Craig have reported the results of three years' feeding of purebred pigs of six leading breeds, including representatives of the Tamworth and Yorkshire breeds. While the pigs were with the dam, records were kept of all feed consumed and the loss or gain, and the loss or gain in weight of the sows was entered in the accounts of the total pork production before weaning. Henry reports the results of trials with 8 litters of pigs at the Wisconsin Station,[a] when he found the feed required for 100 pounds gain by both sows and pigs before weaning to be little more than that required by the pigs alone after weaning. In the Iowa tests there was a very marked variation in the maintenance of flesh by the sows, which was perhaps due rather more to individual than to breed differences, and which had much to do with the economy of the feeding before weaning. The average cost of 100 pounds of gain for the three years' experiments, both for the sows and pigs before the latter were weaned and for the pigs after weaning, was as follows:

Cost of 100 pounds of gain before and after weaning.[a]

Breed.	Sows and pigs before weaning.	Pigs after weaning.	Breed.	Sows and pigs before weaning.	Pigs after weaning.
Berkshire	$4.29	$2.33	Duroc Jersey	$5.61	$2.27
Poland China	3.15	2.23	Yorkshire	1.83	2.14
Chester White	3.27	2.46	Tamworth	2.22	2.42

[a] Bul. No. 48, Iowa Expt. Sta.

According to these figures, sows of the bacon breeds (Yorkshire and Tamworth) only made cheaper gains with their pigs before weaning than the pigs alone after weaning. The Poland China sows showed the cheapest gains among those of the lard, or fat, type.

After weaning the pigs, the Iowa Station[b] put on feed those that were in thrifty condition and compared the same breeds from this standpoint. The conditions of feed and management were as nearly alike as possible for each breed in each year's feeding. The nutritive ratio was 1: 5.8 for all breeds in the first experiment, from 1: 5.5 to 1: 5.7 in the second, and from 1: 7.1 in the third. The first year's work was nearly wrecked by hog cholera, so that the results of only a limited period of time were published. The following table has been arranged from the results, to show the feeding record of each breed in each experiment and the average of each breed for the three years' feeding.

[a] Feeds and Feeding, p. 541.

[b] Bul. No. 48, Iowa Expt. Sta.

Breed tests of pigs—three years' experiments. [a]

Breed.	Number of pigs.	Average age at beginning.	Average weight at beginning.	Average weight at close.	Total gain.	Number of days fed.	Average daily gain.	Dry matter consumed.	Dry matter per 100 pounds gain.	Cost per 100 pounds gain.
Berkshire:		*Days.*	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
First experiment	10	59	26	90	631	92	0.68	2,920	462	3.01
Second experiment	10	43	31	192	1,588	153	1.03	6,056	381	2.17
Third experiment	10	65	43	214	1,717	164	1.04		481	2.23
Average							.98		441	2.33
Poland China:										
First experiment	5	63	40	107	334	92	.72	1,418	424	2.76
Second experiment	8	59	38	201	1,234	153	1.00	4,844	392	2.24
Third experiment	10	54	32	193	1,606	164	.97		441	2.12
Average							.90		419	2.23
Chester White:										
First experiment	10	59	33	103	689	92	.74	3,196	463	2.95
Second experiment	10	49	30	185	1,551	153	1.01	6,113	394	2.28
Third experiment	9	55	26	179	1,383	164	.93		506	2.41
Average							.89		454	2.46
Duroc Jersey:										
First experiment	10	58	34	115	828	92	.90	3,206	383	2.45
Second experiment	9	60	39	207	1,517	153	1.10	5,124	337	2.07
Third experiment	10	52	29	187	1,575	164	.95		506	2.36
Average							.98		410	2.27
Yorkshire:										
First experiment	6	69	35	109	447	92	.80	1,782	398	2.55
Second experiment	9	68	46	225	1,609	153	1.16	5,851	365	2.09
Third experiment	5	61	45	236	957	164	1.16		505	2.04
Average							1.04		423	2.14
Tamworth:										
First experiment	7	49	33	104	502	92	.77	2,028	403	2.62
Second experiment	10	60	52	210	1,539	153	1.00	6,266	407	2.31
Third experiment	8	75	52	221	1,354	164	1.03		558	2.47
Average							.93		456	2.42

[a] Bul. No. 48, Iowa Expt. Sta.

These figures show that the Yorkshires averaged highest in average daily gains, with the Berkshires and Duroc Jerseys tied for second place, and the Tamworth pigs next. In feed (digestible dry matter) required for 100 pounds gain, the Duroc Jerseys were first in least requirement, with the Poland Chinas next, the Yorkshires third, and the Tamworths last. In cost of 100 pounds gain the Yorkshires were first, the Poland Chinas second, the Duroc Jerseys third, and the Tamworths fifth. This evidence seems to disprove the charges sometimes made against the bacon breeds, namely, that these pigs make smaller and more expensive gains than those of other breeds.

Ontario experiments.—From the Ontario Agricultural College, Day has reported a number of experiments with six leading breeds. The pigs were fed for comparative purposes. At the close of each feeding period carcasses were examined for their suitability for the export trade, and reports were made thereon by the packers who killed the pigs. The following table shows the results of the feeding tests for five years, with the average of four:

Breed tests of pigs—five years' experiments.[a]

Breed.	Year of test.	Average weight at beginning.	Average weight at close.	Number of days fed.	Average daily gain.	Feed eaten.	Meal per 100 pounds gain.
		Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
Berkshire	1896	66	185	117	1.010	475	398.00
	1897	53	145	90	1.020	301	327.17
	1898	50	170	112	1.070		369.79
	1899						[b]318.28
	1900				.803		409.00
Average of 4 tests					.978		378.74
Poland China	1896	69	190	117	1.030	507	417.00
	1897	52	128	90	.840	253	332.89
	1898	69	187	112	1.050		383.22
	1899						[b]349.99
	1900				.701		474.00
Average of 4 tests					.905		401.78
Duroc Jersey	1896	62	199	117	1.160	580	424.00
	1897	65	149	90	.940	302	358.05
	1898	59	179	112	1.070		376.04
	1899						[b]337.10
	1900				.883		426.00
Average of 4 tests					1.014		396.02
Chester White	1896	62	185	117	1.050	557	452.00
	1897	52	127	90	.830	255	340.00
	1898	56	175	112	1.060		377.77
	1899						[b]336.68
	1900				.666		433.00
Average of 4 tests					.902		400.69
Yorkshire	1896	50	177	117	1.080	589	468.00
	1897	60	144	90	.930	285	340.62
	1898	52	176	112	1.100		350.10
	1899						[b]334.85
	1900				.930		422.00
Average of 4 tests					1.010		395.18
Tamworth	1896	54	171	117	1.000	469	400.00
	1897	52	139	90	.970	289	330.92
	1898	48	167	112	1.060		377.77
	1899						[b]331.16
	1900				.642		462.00
Average of 4 tests					.918		390.17

[a] An. Rpts., 1896–1900, Ontario Agricultural College. [b] Dry matter, not included in averages.

These figures show that the Duroc Jersey averaged first in average daily gains with 1.014 pounds, the other breeds following in this order: Yorkshire, Berkshire, Tamworth, Poland China, and Chester White. There is, however, very little difference between the Duroc Jersey, Yorkshire, and Berkshire in respect of average daily gains, and the Tamworth, Poland China, and Chester White form a second group, with average daily gains of slightly more than 0.90 pound. In the economy of gain the Berkshire stands first with 378.74 pounds as the amount of meal required for 100 pounds of gain, the other breeds following in this order: Tamworth, Yorkshire, Duroc Jersey, Chester White, and Poland China. In this respect the Berkshire is quite a little in the lead. The Yorkshire and Duroc Jersey form a group around 395 pounds and the Chester White and Poland China another group at 400 pounds. The Tamworth required 390.17 pounds meal for 100 pounds gain—somewhat less than the Yorkshire and Duroc Jersey.

Minnesota experiments.—At the Minnesota Station, Shaw[a] fed pigs of the Tamworth and Yorkshire breeds in comparison with Poland China. Like the Iowa trials, this was really a comparison of the feeding ability of pigs of the bacon type with those of the lard type.

They were fed in pens 8 by 12 feet, with access to yards, but without pasture. The grain fed consisted of shorts, corn meal, and ground barley in varying proportions, and in the first experiment skim milk was fed. In both experiments green and succulent feed, such as pease, oats, corn, rape, and roots, was fed. During the first experiment one lot of Poland China pigs was on a ration that was mainly of corn meal, some shorts being fed in addition. The pigs in the first experiment were sold at $4 per 100 pounds and those of the second at $4.85 per 100 pounds. The following are the results for the purebred lots:

Breed tests of pigs—two experiments.

Breed.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Feed eaten.			Cost per 100 pounds gain.	Profit.
						Meal.	Milk.	Green feed.		
First experiment:		Lbs.	Lbs.		Lbs.	Lbs.	Lbs.	Lbs.	Dollars.	Dollars.
Poland China	3	44	88	126	0.70	378	84	74	2.52	0.86
Poland China (corn-fed)	3	46	84	126	.67	398	44	143	2.31	.96
Tamworth	3	44	117	126	.93	418	44	144	2.01	1.89
Large Yorkshire	3	35	122	126	.97	419	53	161	2.02	2.07
Second experiment:										
Tamworth	3	51	119	126	.94	415	-------	252	2.32	2.68
Large Yorkshire	3	41	134	126	1.06	427	-------	252	2.11	3.40
Poland China	3	44	121	126	.96	454	-------	224	2.48	2.58

Wisconsin experiments.—The Wisconsin Station[b] tabulated the results of feeding for the different breeds and crosses used in an

[a] Bul. No. 73.

[b] Eighteenth An. Rpt., p. 57.

experiment with pease and corn meal. The following table shows the averages:

Results of feeding pigs of various breeds and crosses.

Breeding.	Number of pigs.	Average amount of grain eaten daily.	Average daily gain.	Total gain per pig.	Feed per 100 pounds gain.	Cost per 100 pounds gain.	Internal fat.	Thickness of surface fat.
		Pounds.	*Pound.*	*Pounds.*	*Pounds.*	*Dollars.*	*Pounds.*	*Inches.*
Razorback-Poland China	2	4.27	0.985	166	433	4.997	13.35	2.705
Razorback-Berkshire	2	2.86	.57	119	505	5.772	9.52	2.32
Small Yorkshire	2	3.52	.875	148	400	4.556	9.67	2.21
Razorback	4	2.73	.52	110	547	6.227	10.378	1.99

Particular attention is called to the low gains of the Razorbacks, the large amount of feed they required for 100 pounds gain, and the large amount of internal fat.

In the Wisconsin[a] experiment to compare pease and middlings with corn meal the Berkshires made an average gain in one hundred and twenty-six days of 169 pounds—an average of 1.34 pounds daily for each pig. The Poland Chinas gained 153 pounds each—an average of 1.21 pounds each daily. The Yorkshires, leaving out of consideration a pig that fed poorly, made an average gain in one hundred and twenty-six days of 137 pounds—an average daily gain each of 1.08 pounds. The authors of the Wisconsin report state that this should not be regarded as a breed test.

These experiments, taken in connection with the evidence of investigators over the entire country, undoubtedly show that representative pigs of the different breeds do not differ materially either in the rate of gain or the economy with which the gains are made. Any marked differences in the breeds will be manifested in the suitability of the fattened animals for market and the quality of the carcass on the block. A very notable feature is the showing of the bacon breeds when compared with the lard breeds. The fact that a pig is a Yorkshire or a Tamworth can not be taken as prima facie evidence that it will make slow and expensive gains.

Value of different crosses.—At the Minnesota Station, Shaw[b] fed four lots of pigs to determine the relative value of Yorkshire pigs of first and second crosses. The pigs of the first cross were by a purebred Large Improved Yorkshire boar out of a high-grade Berkshire sow. Those of the second were sired by the same Yorkshire boar, out of a sow whose dam was the grade Berkshire that was the dam of the first litter and whose sire was a purebred Yorkshire. The four lots were therefore as nearly identical in breeding as possible without extreme inbreeding.

Lots I and III were first-cross pigs and Lots II and IV second cross. Lots I and II received a corn-and-oats diet and Lots III and IV a

[a] Seventeenth An. Rpt., p. 16. [b] Bul. No. 60.

barley-and-oats ration; and each lot had an 8 by 12 foot pen in a piggery, with a small paddock adjoining, where they ran for an hour or two daily.

The corn-and-oats ration was 1 part corn to 3 parts oats during the first period; during the second, 2:2; during the third, 3:1; and during the fourth, corn only. In the barley-and-oats rations barley substituted corn in the same proportion. Grain was ground, soaked twelve hours, and a little salt given at each feed. The pigs received all they would eat with relish. Some green feed, such as corn, second-growth clover, rape, and cabbage, was given.

Feeding tests of different crosses.

Breeding.	Number of pigs.	Age at beginning.	Total weight at beginning.	Total weight at close.	Total gain.	Number of days fed.	Average daily gain.	Grain feed eaten.	Green feed eaten.	Grain feed per 100 pounds gain.	Green feed per 100 pounds gain.	Cost per 100 pounds gain.
		Days.	*Lbs.*	*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*
Lot I, first cross	3	108	247	601	354	112	1.05	1,394	322	393	111	1.65
Lot II, second cross	3	108	275	603	328	112	.98	1,483	297	452	90	1.89
Lot III, first cross	3	108	247	526	279	112	.83	1,178	267	422	95	1.83
Lot IV, second cross	3	108	279	567	288	112	.86	1,284	297	445	103	1.96

Other comparative results were as follows:

Average daily gain of first-cross	pound	0.94
Average daily gain of second-cross	do	.92
Cost of 100 pounds gain of first cross	dollars	1.74
Cost of 100 pounds gain of second cross	do	1.93

Comparing differing crosses.—Shaw[a] conducted two experiments to compare crosses of different breeds. The pigs were fed in 8 by 12 foot pens, with access to yards and lots adjoining for exercise, but no pasture. They were fed eighteen weeks. The feed was a mixture of shorts, corn, and barley, some green and succulent feed in season, such as peas, oats, rape, corn, and roots was given in each experiment, and all conditions were similar, except that during the first experiment the pigs had skim milk.

The pigs of the first experiment were sold at $4 per 100 pounds; those of the second, at $4.85 per 100 pounds.

The breeding was as follows:

First experiment:
- Tamworth-Poland China cross.
- Second cross, Large Improved Yorkshire on Berkshire.
- Third cross, Large Improved Yorkshire on Berkshire.
- Large Improved Yorkshire-Poland China cross.

[a] Bul. No. 73, Minnesota Expt. Sta.

Second experiment:

Third cross, Large Improved Yorkshire on Berkshire.
Large Improved Yorkshire–Poland China cross.
Tamworth–Poland China cross.
Large Improved Yorkshire–Poland China cross (Minnesota-bred dam).
Large Improved Yorkshire–Berkshire cross.

In the first experiment "The Tamworth–Poland China and Large Improved Yorkshire–Poland China crosses were obtained similar to those above described[a] and from a pure Tamworth and pure Large Improved Yorkshire sire, respectively. The second cross, or grade, of Yorkshire on Berkshire was from a dam the progeny of a Large Improved Yorkshire sire and a dam essentially Berkshire, but not registered. The third cross of Yorkshire on Berkshire was of breeding similar in kind, but once removed further from the original Berkshire dam."

In the second experiment there were some slight changes; the pigs of one Yorkshire–Poland China lot were out of a dam reared in the corn belt, while those of the other were out of a Minnesota-bred dam. "In several instances, however, the blood lines were not only the same, but the animals in the experiment were from the same sire and dam, as were those of the previous year." The results follow:

Feeding tests of crossbred pigs.

Breeding.	Number of pigs.	Average weight at beginning.	Average gain.	Number of days fed.	Average daily gain.	Feed eaten.			Cost per 100 pounds gain.	Profit.
						Grain.	Milk.	Green feed.		
First experiment:		*Lbs.*	*Lbs.*		*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Dolls.*	*Dolls.*
Tamworth-Poland China	2	47	118	126	0.94	456	83	80	2.24	1.61
Second cross, Yorkshire-Berkshire	3	56	131	126	1.04	499	72	108	2.17	1.84
Third cross, Yorkshire-Berkshire	3	33	104	126	.83	410	47	142	2.28	1.46
Yorkshire-Poland China	3	48	128	126	1.02	483	44	145	2.16	1.87
Second experiment:										
Third cross, Yorkshire-Berkshire	3	45	126	126	1.00	427	......	252	2.25	2.98
Yorkshire-Poland China	2	63	166	126	1.32	577	......	252	2.28	3.86
Tamworth-Poland China	3	48	147	126	1.17	482	......	252	2.16	3.64
Yorkshire-Poland China (Minnesota-bred dam)	3	49	158	126	1.25	527	......	252	2.18	3.89
Yorkshire-Berkshire	3	46	152	126	1.21	564	......	196	2.43	3.38

Among Shaw's conclusions are the following remarks:

That the experiments do not sustain the view that the results will be less satisfactory from each succeeding cross of Yorkshire on Berkshire.

That the cross of Large Improved Yorkshire and Tamworth breeds upon the

[a] See experiments with crossbred swine, pp. 183, 184.

Poland China sows of the corn-reared types produces animals at once vigorous, shapely, of better growth, and relatively more profitable than pigs from the aforementioned sows.

INFLUENCE OF BREED ON THE CARCASS.

For the sake of convenience the term "slaughter test" is used in this bulletin to include everything from weighings on the floor of a packing house to a chemical analysis. Sufficient attention has not been paid to the effect of feed and conditions of management on the carcass, but the present drift of sentiment among workers in animal husbandry points to a more thorough study of the carcass in detail as a means of solving the problems that still confront the student and the feeder. No one can doubt that such investigations will have a high value when applied under feed-lot conditions.

At the close of the last two Iowa[a] experiments most of the hogs were shipped to Chicago and sold on the open market. In both experiments the different breeds had been fed on practically the same rations, and all conditions of feeding and management were similar; so that whatever differences might be found in the carcasses could very properly be ascribed to breed influence. In the packing house where the hogs were killed careful records were kept of the slaughtering, and elaborate reports made of these records. The following table has been arranged from these results. It shows the percentage of dressed weight of each breed and the total and average weights of the heads and viscera for each breed:

NOTES ON THE FOLLOWING TABLE.

NOTE.—The writer is under obligations to Swift & Co., Chicago, who killed the hogs, for the following explanation of terms used in these slaughter tests that are not self-explanatory:

Heads, gross.—The gross weight of the heads just as cut from the hogs, with tongues and lean meat in.

Heads, net.—The same heads trimmed for tank—tongues, cheek meat, and cheek-meat fat taken out.

Cheek meat.—Refers to the lean meat in the cheek of the hog. Scientifically expressed, includes masseter (*pterygoideus internus* and *externus*) muscles.

Cheek-meat fat.—The fat trimmed off in saving the lean meat.

Ham facings.—Refers to the facing of fat which is taken off the inside of the hams in order to give them a lean appearance and is taken off in all cases where American cut hams are made Where English long-cut hams are made this facing of fat is left on, accounting for the fact that in some of the tests ham facings are shown; in other tests they are not.

Plucks.—The liver, heart, and lungs comprise what is called the pluck. Total weight of the livers, hearts, and lungs added together should agree with the total weight of the plucks. Some differences in 1897 test, but weights balance approximately in 1898 test.

Bladders, gross.—The weight of the bladders as taken from the hogs filled, more or less, with urine.

Bladders, net.—Weight of the same bladders with the urine pressed out.

Gut fat.—Large intestines washed out.

Caul fat.—Omentum.

Ruffle fat.—Mesentery.

Bung guts, gross.—Floating colon and rectum combined is called the bung gut, and bung guts, gross, is weight before being cleaned.

Bung guts, net.—Same as above, but cleaned.

Paunches, gross.—Weight of stomachs as taken from the hogs.

Paunches, net.—Weight of stomachs cleaned.

Pig bags.—Refers to uteri.

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[a] Bul. No. 48.

Slaughter tests of purebred hogs.

Breed.	Number of pigs.	Dressed meat.	Melts (spleen).	Heads. Gross.	Heads. Net.	Tongues.	Cheek meat.	Cheek-meat fat.	Leaf lard.	Kidneys.	Gullets.	Gullet fat.
		Per cent.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Berkshire	10	76.20	3.00	105.00	85.00	8.00	10.00	2.00	40.00	3.00	12.00	0.50
	9	77.90	1.75	96.00	78.00	8.00	8.75	1.12	57.00	5.75	5.50	1.25
Average		77.04	.25	10.58	8.58	.84	.99	.16	5.11	.46	.92	.09
Tamworth	10	78.40	5.00	115.00	95.00	7.00	8.00	2.00	70.00	5.00	9.50	.50
	4	78.60	1.50	43.75	36.00	3.50	3.50	.75	15.00	3.00	2.50	.50
Average		78.46	.46	11.34	9.36	.75	.82	.20	6.07	.57	.86	.07
Chester White	9	78.40	4.00	98.00	75.00	5.00	6.00	2.00	55.00	3.00	9.50	.50
	8	77.80	1.50	78.75	65.00	5.75	6.50	1.50	45.00	4.50	5.25	1.75
Average		78.10	.32	10.40	8.24	.63	.74	.21	5.88	.44	.87	.13
Poland China	8	78.20	3.00	75.00	60.00	5.00	6.00	2.00	48.00	5.00	7.00	1.00
	9	79.00	2.50	84.25	70.00	6.00	7.00	1.25	48.00	5.00	6.00	1.50
Average		78.62	.32	9.37	7.65	.65	.77	.19	5.65	.59	.76	.15
Duroc Jersey	9	77.10	4.00	100.00	82.00	8.00	8.00	2.00	62.00	3.50	9.00	1.00
	9	77.00	2.12	86.00	70.00	6.25	7.25	2.25	41.00	5.00	6.50	3.50
Average		77.05	.34	10.34	8.45	.79	.85	.23	5.73	.48	.86	.25
Yorkshire	9	79.00	4.00	110.00	93.00	8.00	8.00	1.00	50.00	4.33	10.00	1.00
	4	79.60	1.25	42.25	35.00	3.25	3.25	.75	23.00	2.50	2.50	.50
Average		79.18	.40	11.71	9.85	.87	.87	.13	5.62	.53	.96	.11

Slaughter tests of purebred hogs—Continued.

Breed.	Ham facings.	Plucks.	Livers.	Hearts.	Lungs.	Bladders.	Bladders. Gross.	Bladders. Net.	Bladder fat.	Total weight of guts.	Gut fat.	Caul and ruffle.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Berkshire	4.00	64.00	32.00	6.00	15.00		3.00	1.00	0.50	205.00	24.00	26.00
		50.50	25.00	5.50	20.00	0.50				218.00	31.00	32.50
Average		6.03	3.00	.61	1.84					22.26	2.90	3.08
Tamworth	4.00	60.00	26.00	6.00	18.00		3.00	1.00	.50	200.00	30.00	25.00
		24.75	11.00	2.75	11.00	.50				91.00	13.00	14.50
Average		6.05	2.64	.63	2.70					20.80	3.07	2.82
Chester White	4.00	50.00	25.00	5.00	10.00		2.00	1.00	.50	173.50	30.00	25.00
		37.25	19.00	4.25	14.00	1.00				156.00	29.00	24.00
Average		5.13	2.59	.54	1.41					19.38	3.47	2.88
Poland China	4.00	50.00	27.00	5.00	10.00		2.50	.50	.50	128.50	27.00	23.00
	10.50	44.25	27.00	4.75	12.50	1.00				175.00	28.00	18.00
Average	.85	5.54	3.18	.57	1.32					17.85	3.24	2.41
Duroc Jersey	4.00	55.00	25.00	5.00	15.00		2.00	.50	.50	189.00	25.00	29.00
	8.00	43.50	25.50	5.00	13.00	.75				194.00	30.00	28.50
Average	.66	5.47	2.80	.56	1.56					21.28	3.05	3.20
Yorkshire	4.00	60.00	27.00	4.00	18.00		4.00	1.00	.50	194.00	33.00	22.00
		25.00	13.00	2.50	9.50	.50				82.00	16.00	12.50
Average		6.54	3.08	.50	2.12					21.23	3.77	2.65

Breed.	Bung guts.		Bung-gut fat.	Pig bags.	Small guts.		Stomachs.		Nutritive ratio.
	Gross.	Net.			Gross.	Net.	Gross.	Net.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Berkshire	7.00	5.00	10.00	3.00	40.00	25.00	15.00	12.00	1:5.6
	14.00	6.00		2.25	34.00	19.00	21.00	14.00	1:7.1
Average	1.11	.58		.28	3.90	2.32	1.90	1.37	
Tamworth	8.00	6.00	10.00	2.00	44.00	31.00	16.00	14.00	1:5.6
	7.50	3.00		2.50	12.00	8.00	11.00	7.00	1:7.1
Average	1.11	.64		.32	4.00	2.80	1.93	1.50	
Chester White	6.00	4.00	9.00	1.50	31.00	20.00	15.00	10.00	1:5.5
	10.00	4.00		.75	25.00	15.00	15.00	11.00	1:7.1
Average	.98	.47		.13	3.30	2.06	1.76	1.24	
Poland China	5.00	4.00	5.00	3.00	27.00	18.00	10.00	7.00	1:5.7
	15.00	5.00		1.75	27.00	17.50	15.50	13.00	1:7.1
Average	1.18	.53		.28	3.18	2.09	1.50	1.18	
Duroc Jersey	8.00	7.00	7.00	3.00	32.00	20.00	18.00	11.00	1:5.6
	14.75	6.75		2.25	33.00	22.00	17.00	13.00	1:7.1
Average	1.27	.76		.29	3.61	2.33	1.95	1.33	
Yorkshire	5.00	4.75	10.00	2.50	25.00	18.00	21.00	13.00	1:5.6
	7.00	3.00		.50	14.00	8.00	7.00	6.00	1:7.1
Average	.92	.60		.23	3.00	2.00	2.15	1.46	

The average of these tests shows the Yorkshire to be in the lead in dressed weight, the other breeds following in this order: Poland China, Tamworth, Chester White, Duroc Jersey, and Berkshire, the variation being from 79.18 per cent to 77.04 per cent.

Relative weights of vital organs.—The weight of vital organs is highly important. To ascertain what variations the Iowa[a] test showed in this respect the table below has been arranged. It shows the percentages of the weights of the vital organs to live weight for each breed in each experiment, with the average of both.

The average live weights of the hogs at the abattoir were as follows:

Average live weights of hogs of different breeds—Iowa experiments.

Breed.	1897.	1898.
	Lbs.	*Lbs.*
Berkshire	190	209
Tamworth	200	215
Chester White	177	181
Poland China	193	191
Duroc Jersey	202	180
Yorkshire	215	232

Relative weights of vital organs of purebred hogs.[a]

Breed.	Number of pigs.	Melts (spleen).	Tongues.	Kidneys.	Gullets.	Plucks.	Livers.	Hearts.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Berkshire:								
First experiment	10	0.16	0.42	0.16	0.63	3.37	1.68	0.32
Second experiment	9	.09	.43	.31	.29	2.68	1.38	.30
Average		.13	.42	.23	.46	3.03	1.50	.31
Tamworth:								
First experiment	10	.25	.35	.25	.48	3.00	1.30	.30
Second experiment	4	.18	.41	.35	.29	2.88	1.28	.32
Average		.23	.37	.28	.42	2.97	1.29	.31
Chester White:								
First experiment	9	.25	.32	.19	.60	3.14	1.57	.32
Second experiment	8	.10	.40	.31	.36	2.57	1.31	.29
Average		.18	.35	.25	.49	2.87	1.45	.30
Poland China:								
First experiment	8	.20	.33	.33	.46	3.24	1.75	.33
Second experiment	9	.15	.35	.29	.35	2.58	1.57	.28
Average		.17	.34	.31	.40	2.89	1.66	.30
Duroc Jersey:								
First experiment	9	.22	.44	.19	.50	3.02	1.38	.28
Second experiment	9	.13	.38	.31	.40	2.68	1.57	.31
Average		.18	.41	.25	.45	2.86	1.47	.29
Yorkshire:								
First experiment	9	.20	.41	.22	.52	3.10	1.40	.20
Second experiment	4	.13	.35	.27	.27	2.69	1.40	.27
Average		.18	.40	.24	.44	2.97	1.40	.23

[a] Bul. No. 48, Iowa Expt. Sta.

Relative weights of vital organs of purebred hogs—Continued.

Breed.	Lungs.	Bladders.	Bladders, net.	Total weight of guts.	Bung guts, net.	Small guts, net.	Stomachs, net.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Berkshire:							
First experiment	0.79	----------	0.05	10.79	0.26	1.32	0.63
Second experiment	1.10	0.03	----------	11.99	.33	1.04	.77
Average	.92	----------	----------	11.19	.29	1.16	.69
Tamworth:							
First experiment	.90	----------	.05	10.00	.30	1.55	.70
Second experiment	1.28	.06	----------	10.58	.35	.93	.81
Average	1.01	----------	----------	10.19	.31	1.37	.74
Chester White:							
First experiment	.62	----------	.06	10.89	.25	1.25	.62
Second experiment	.97	.07	----------	10.77	.28	1.04	.76
Average	.79	----------	----------	10.83	.26	1.15	.69
Poland China:							
First experiment	.65	----------	.03	8.32	.26	1.17	.46
Second experiment	.73	.04	----------	10.17	.29	1.02	.75
Average	.69	----------	----------	9.30	.28	1.09	.61
Duroc Jersey:							
First experiment	.83	----------	.11	10.44	.39	1.10	.60
Second experiment	.80	.44	----------	11.98	.42	1.36	.80
Average	.82	----------	----------	11.14	.40	1.22	.70
Yorkshire:							
First experiment	.93	----------	.20	10.03	.25	.93	.67
Second experiment	1.03	.06	----------	8.84	.32	.86	.64
Average	.96	----------	----------	9.65	.27	.91	.66

In the relative amounts of spleen there are only two variations from a general average—the Tamworths, with 0.23 per cent, and the Berkshires, with 0.13 per cent.

In weight of kidneys the Poland Chinas lead, with 0.31 per cent, the Berkshires being lowest, with 0.23 per cent.

There does not appear to be any particularly constant influence due to breed or type in the relative weights of those vital organs that constitute the pluck. The combined weights of liver, heart, and lungs should approximate that under the head of pluck; if, therefore, there is any influence of breed on the development and weights of these organs we should expect to find evidences of it in uniform and constant differences in weights. In the weight of plucks the Berkshires lead in the average, with 3.03 per cent, the Tamworth, Yorkshire, Poland China, Chester White, and Duroc Jersey following in the order named, the lowest weight being 2.86 per cent of the live weight. Yet, in relative weights of the organs that are included in the pluck, the Berkshires are but once in the lead—in the weight of the heart, where less variation is seen than in the weights of livers and lungs, the

Yorkshire being the only breed that shows much variation from the general average. The variation in weights of livers and lungs is quite erratic. Poland Chinas lead in relative weight of livers, with 1.66 per cent, the other breeds following thus: Berkshire, Chester White, Duroc Jersey, Yorkshire, and Tamworth, the least amount being 1.28 per cent of the live weight. The Tamworths lead in relative weight of lungs, with 1.01 per cent, the other breeds following in this order: Yorkshire, Berkshire, Duroc Jersey, Chester White, and Poland China, the lowest weight being 0.69 per cent of the live weight.

We find some appearance of uniformity in the weights of stomach and intestines. The heading "Total weight of guts" includes, among others, the three items that follow it. The Berkshires lead in this respect, with 11.19 per cent, the breeds following thus: Duroc Jersey, Chester White, Tamworth, Yorkshire, and Poland China, the lowest weight being 9.3 per cent of the live weight. The Duroc Jerseys lead in net weight of bung guts, with 0.4 per cent, the breeds following in this order: Tamworth, Berkshire, Poland China, Yorkshire, and Chester White, the lowest weight being 0.26 per cent of the live weight. The Tamworths lead in net weight of small guts, the weight being 1.37 per cent; the other breeds stand thus: Duroc Jersey, Berkshire, Chester White, Poland China, and Yorkshire, the lowest weight being 0.91 per cent. In net weight of stomachs the Tamworths lead, the breeds following in this order: Duroc Jersey, Berkshire, Chester White, Yorkshire, and Poland China, the weights ranging from 0.74 per cent to 0.61 per cent of the live weight. The record of the Berkshires and Duroc Jerseys is seen to be fairly uniform. Definite conclusions can not be drawn from these figures and it may be questioned whether, in the light of the facts concerning the feeding possibilities of the different breeds on similar rations, the improved breeds will show any marked and uniform differences in the relative weights of the internal organs when fed on the same feed.

Lard yield of different breeds.—By common consent, the name "lard hog" has been applied by many people to that type of animal the development of which has very largely been brought about on American soil, in contradistinction from the "bacon" type of hog which has been brought to us from Great Britain and Canada.

The writer is under obligation to Swift & Co., Chicago, who killed the hogs used in the Iowa experiments, for the following information regarding the lard yield of the different breeds in the test of 1898. Concerning their figures, they say:

> We did not, on any of the tests made, tank the fats of each lot separately, the amounts being too small. However, we know approximately what these fats should yield in rendered lard, and we have attached herewith a statement showing the different test lots slaughtered by us during November, 1898, and what we estimate the fats, etc., should yield in lard.
>
> For your information we beg to say that the ham facings, heads, cheek-meat fat, gullet fat, gut fat, caul and ruffle fat, bones, tails, feet, and fat trimmings are.

as a rule, tanked for lard by most packers, although at times some of the bones, tails, and pig feet are saved for offal trade and not rendered. The raw leaf also at times is saved for neutral and not rendered out as steam lard.

We have, however, in the table attached shown what all these fats and bones, if rendered out as lard, would amount to, as all these fats and bones go to make up the yield published by the Cincinnati Price Current, quoted by you.

* * * These yields are lighter than the averages shown by the Cincinnati Price Current and can be explained for the reason that all the hogs in these tests were made into English cuts, which invariably show a less yield in lard, on account of the smaller percentage of fats being tanked, than the same hogs would show if cut up as American cuts.

In estimating the yield of lard from the different fats, etc., the percentages of lard to actual weight for the various items are given as follows:

		Lard equivalent.
Ham facings	per cent	75
Heads, cheek-meat fat, gullet fat	do	35
Leaf lard	do	95
Bones and tails	do	17
Fat trimmings	do	75

The lard from the gut fat and the caul and ruffle fat is estimated at 2 per cent of the live weight.

The following table shows the calculations for all the hogs of the 1898 test for which a slaughter record was kept:

Lard yield of different breeds.

Breed.	Number of hogs.	Live weight.	Average live weight.	Ham facings.		Heads, cheek-meat fat, and gullet fat.		Leaf lard.	
				Weight.	Lard equivalent.	Weight.	Lard equivalent.	Weight.	Lard equivalent.
		Pounds	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Duroc Jersey	9	1,620	180	8	6	78.75	27.56	41	38.95
Poland China	9	1,720	191	10.5	7.87	72.75	25.46	48	45.60
Tamworth	4	860	215			37.25	13.03	15	14.25
Berkshire	9	1,880	209			80.37	28.13	57	54.15
Yorkshire	4	930	232			36.25	12.68	23	21.85
Chester White	8	1,450	181			68.25	23.88	45	42.75

Breed.	Number of hogs.	Gut, caul, and ruffle fat—Lard equivalent.	Bones and tails.		Fat trimmings.		Yield of total lard.	Average yield of lard.	Proportion of live weight.
			Weight.	Lard equivalent.	Weight.	Lard equivalent.			
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per ct.*
Duroc Jersey	9	32.40	56.50	9.60	91.5	68.62	183.13	20.35	11.30
Poland China	9	34.40	59	10.03	103	77.25	200.61	22.29	11.66
Tamworth	4	17.20	39.50	6.71	56.5	42.37	93.56	23.39	10.88
Berkshire	9	37.60	67.25	11.43	103	77.25	208.56	23.17	11.09
Yorkshire	4	18.16	35.75	6.08	64	48	107.21	26.80	11.57
Chester White	8	19	53.25	9.05	88.5	66.37	161.05	20.13	11.11

INFLUENCE OF FEED ON THE CARCASS.

INFLUENCE OF WIDE AND NARROW RATIONS.

One of the earliest subjects for investigation in pork production was the influence of feed on the carcass. Following this line of study experiment-station workers have proved pretty accurately that, where a pig is fed a ration that is poor in those feed constituents whose function is to build up muscular fiber and is rich in carbohydrates, the carcass will probably show a development of fat at the expense of the lean meat (muscular fiber), and that, where a large proportion of protein is fed and a relatively small amount of carbohydrates, there is a correspondingly smaller development of fat and a larger development of muscular tissue and bone. Out of this came the ideas that instructed farmers to "feed for lean," or, rather, to strike a mean between rations and feed one that would supply fat, energy, and muscle-producing materials in the requisite proportions. The slaughter test early accompanied this branch of investigation, and from a mere estimation of the relative amounts of fat and lean has come to include the weighings of the internal organs and to involve chemical analyses.

The slaughter test was a feature of the experiments in Wisconsin and Iowa with wide and narrow rations that are discussed in the foregoing pages. The following tables show the data for the slaughterings in the actual and relative weights and the measurements of the parts.

The Wisconsin experiments.—The following table shows the slaughter test of the Wisconsin pigs that were fed a ration of ground pease, middlings, and milk in comparison with corn meal and milk:

Slaughter test of pigs fed a ration of ground pease and shorts, in comparison with corn meal.[a]

Breed.	Gain in eighteen weeks.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Liver.	Kidney.	Intestines and stomach.	Length of body.	Length of small intestines.	Length of large intestines.	Intestinal fat.	Kidney fat.
Lot I. Corn meal and milk:	*Lbs.*	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Lbs.*	*Lbs.*
Berkshire	190	270	218.0	80.74	7.1	3.7	6.0	19.7	43.0	789.0	216.0	6.3	12.5
Do	197	282	230.0	81.56	7.0	2.9	4.0	15.8	42.0	689.0	180.0	5.2	13.25
Yorkshire	115	177	131.0	74.00	6.2	.....	6.0	14.0	39.0	758.0	....	3.0	7.0
Poland China	156	229	180.0	78.61	5.3	.....	5.0	14.5	41.0	730.0	204.0	3.0	8.0
Berkshire	143	227	187.0	82.37	6.1	2.7	6.0	16.7	39.0	786.0	174.0	3.6	7.5
Do	182	256	207.0	80.85	6.1	.7	6.0	18.7	42.0	789.0	....	5.1	11.0
Poland China	214	300	230.0	79.66	7.0	.....	6.0	22.0	43.0	784.0	....	4.3	12.0
Average	171	249	197.5	79.6	6.4	3.0	5.6	17.3	41.3	760.7	193.5	4.35	10.18

[a] Seventeenth An. Rpt., Wisconsin Expt. Sta.

Slaughter test of pigs fed a ration of ground pease and shorts, etc.—Continued.

Breed.	Gain in eighteen weeks.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Liver.	Kidney.	Intestines and stomach.	Length of body.	Lenth of small intestines.	Length of large intestines.	Intestinal fat.	Kidney fat.
Lot II. Ground pease, shorts, and milk:	*Lbs.*	*Lbs.*	*Lbs.*	*P. ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Lbs.*	*Lbs.*
Poland China	153	203	151	74.38	5.6	.....	6.0	19.5	38.0	702.0	....	3.0	7.0
Do	95	167	128	76.69	7.3	.....	5.0	14.3	34.0	708.0	....	2.3	2.5
Yorkshire	139	217	171	78.08	8.3	.....	7.0	22.5	40.0	799.0	240.0	3.3	7.0
Do	167	217	160	73.73	8.0	.....	5.0	24.0	43.0	720.0	....	3.0	7.25
Poland China	147	225	170	75.55	6.5	5.7	7.0	20.5	39.0	741.0	....	3.7	10.0
Berkshire	168	241	200	82.98	8.8	4.5	6.0	20.0	41.0	678.0	180.0	3.4	8.8
Do	244	215	178	82.69	5.7	4.0	5.0	18.4	39.0	708.0	180.0	5.0	10.5
Do	158	223	191	86.03	7.2	3.9	7.0	20.0	40.0	802.0	....	3.4	7.5
Average	146	213	169	78.88	7.17	4.5	6.0	19.9	39.2	732.2	200.0	3.4	7.56

In this table it is found that the vital organs of the pigs on ground pease and middlings averaged heavier in proportion to their live weight than those on corn meal. These facts are best illustrated in the following table:

Average actual and relative weights of blood, vital organs, and fat of pigs fed on wide and narrow rations.[a]

	Wide ration.		Narrow ration.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Live weight	249.00	100.00	213.0	100.00
Dressed weight	197.50	79.60	169.0	78.88
Blood	6.40	2.57	7.17	3.37
Liver	3.00	1.20	4.5	2.11
Kidneys	.35	.14	.375	.18
Intestines and stomach	17.30	6.95	19.9	9.34
Intestinal fat	4.35	1.75	3.4	1.60
Kidney fat	10.18	4.09	7.56	3.55

[a] Seventeenth An. Rpt., Wisconsin Expt. Sta.

We see that the pigs fed on pea meal, middlings, and skimmed milk developed very much more in the vital organs in proportion to their live body weight than those fed on corn meal and skimmed milk. The difference was most marked in the livers, where the relative weight for the narrow-ration pigs was almost twice as great as for the wide-ration pigs. The same proportion does not hold when the relative lengths of intestines to body lengths are compared. There is very little difference between the pigs of the two lots in this respect. The ratio of body length to that of the small intestine in the wide-ration pigs was 1:18.42; to that of the large intestine, 1:4.69. The ratio of body length to the length of small intestine of the narrow-ration pigs was 1:18.68; to that of the large intestine, 1:5.10.

The following table shows the slaughter test of the pigs fed pea meal and shorts in comparison with corn and rye meals:

Slaughter test of pigs fed a ration of pea meal and shorts in comparison with corn and rye meals.[a]

Breed.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Intestines.	Spleen.	Liver.	Stomach.	Heart.	Intestinal fat.	Kidney fat.	Length of small intestines.	Length of large intestines.	Length of body.	Weight of kidneys.
Lot I, corn and rye meals:	*Lbs.*	*Lbs.*	*P.ct.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Lbs.*	*Ozs.*	*Lbs.*	*Lbs.*	*Ins.*	*Ins.*	*Ins.*	*Ozs.*
Poland China	223.0	183.0	82.0	5.20	18.10	2.4	3.20	4.80	8.00	3.40	7.87	660.0	187.2	38.5	8.00
Yorkshire	208.0	162.0	77.8	5.40	17.30	4.0	3.00	6.60	8.00	2.80	6.00	684.0	196.8	39.5	6.00
Berkshire	214.0	175.0	81.7	4.90	15.60	3.2	2.70	3.10	8.00	2.70	8.50	615.0	180.0	38.0	8.00
Razorback-Poland China	244.0	195.0	79.9	6.40	17.50	4.8	3.50	4.20	9.60	2.70	9.00	684.0	168.0	-----	10.00
Do	182.0	144.0	79.1	4.70	15.30	4.0	2.50	4.10	8.00	2.70	7.87	624.0	168.0	37.0	5.00
Average	212.2	171.8	80.1	5.32	16.76	3.8	2.98	4.36	8.32	2.68	7.84	653.4	180.0	33.2	7.40
Lot II, pea meal and shorts:															
Berkshire	205.0	158.0	77.0	4.70	15.30	4.8	4.00	4.10	6.40	2.50	5.50	615.0	184.8	37.0	6.25
Poland China	179.0	140.0	78.2	5.30	16.90	3.2	3.80	4.10	8.00	2.30	8.30	610.2	192.0	34.0	9.00
Razorback-Poland China	177.0	133.0	75.1	5.40	18.10	3.2	3.10	4.60	6.40	2.70	6.50	607.2	184.8	33.5	8.00
Do	203.0	152.0	74.8	6.20	24.00	4.8	3.80	5.70	8.80	3.80	9.37	732.0	204.0	38.0	16.00
Average	191.0	145.6	76.2	5.40	16.57	4.0	3.66	4.62	7.40	2.82	7.41	641.1	188.4	35.5	9.86

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

For the sake of uniformity the following table has been arranged from the Wisconsin figures to show the relative weights of blood, vital organs, and fat for the pigs of this experiment:

Average actual and relative amounts of blood, vital organs, and internal fat of pigs fed pea meal and shorts in comparison with corn and rye meals.[a]

	Wide ration.		Narrow ration.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Live weight	214.2	100	191	100
Dressed weight	171.8	80.1	145.6	76.2
Blood	5.32	2.48	5.4	2.83
Liver	2.98	1.39	3.66	1.92
Heart	.52	.24	.4625	.24
Stomach	4.36	2.04	4.62	2.42
Intestines	16.76	7.82	16.57	8.15
Kidneys	.4625	.22	.61625	.32
Spleen	.2375	.11	.25	.13
Intestinal fat	2.68	1.25	2.82	1.48
Kidney fat	7.84	3.66	7.41	3.88

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

In this experiment the differences in the relative weights of the vital organs is evident, but is by no means as marked as it was in the experiment which compared corn meal and the mixture of pea meal

and middlings. In fact, while the differences are uniformly in favor of the pigs fed a narrow ration, they are hardly large enough to be of moment in such a test. There was no difference in the relative weights of the hearts of the two lots. The relative length of body to length of intestines is still more contradictory in this test, being 1:19.68 and 1:5.43, respectively, for the small and large intestines of the wide-ration pigs; and 1:18.06 and 1:5.30, respectively, for the small and large intestines of the pigs fed the ration of pea meal and shorts. If it is true that a narrow ration has an influence on the development in weight and length of the vital organs, the fact that the rations were somewhat wider in this experiment than in the first one may have caused this result, although it is difficult to see what effect the widening could have had with one lot more than with another, because the increase in the ration was the same for both lots. A more reasonable explanation would be that the greater disparity in the variety of feed in the first experiment was the cause for the more pronounced development in the weight of the vital organs and blood. This experiment was the one that showed the advantage in feeding value of the narrower ration, which fact merely serves to complicate matters. A peculiar fact in this experiment is the greater accumulation of interna fat by the pigs on the narrow ration.

The following table shows the slaughter test of the pigs fed pea meal in comparison with corn meal:

Slaughter test of pigs fed a ration of corn meal in comparison with one of ground pease. [a]

Breed.	Live weight.	Dressed weight.	Dressed weight.	Blood.	Intestines.	Spleen.	Liver.	Heart.	Capacity of stomach.	Intestinal fat.	Kidney fat.	Length of small intestines.	Length of large intestines.	Length of body.	Weight of kidneys.
Lot I, ground peas:															
Razorback-Berkshire	*Lbs.* 171.0	*Lbs.* 130.0	*P. ct.* 76.0	*Lbs.* 4.40	*Lbs.* 13.70	*Ozs.* 4.00	*Lbs.* 2.20	*Ozs.* 8.00	*Lbs.* 9.20	*Lbs.* 3.10	*Lbs.* 7.125	*Ins.* 688.0	*Ins.* 180.0	*Ins.* 37.5	*Ozs.* 8.0
Yorkshire	189.0	144.0	76.5	5.80	15.80	3.20	3.20	6.40	8.30	1.90	8.250	600.0	222.0	36.0	6.0
Razorback	186.0	142.0	76.3	5.20	13.70	3.20	2.90	6.40	7.90	3.70	7.187	636.0	180.0	39.5	10.0
Razorback-Poland China	219.0	167.5	76.8	6.80	18.20	2.40	3.50	6.40	9.70	3.50	9.250	636.0	192.0	39.0	14.0
Razorback	191.0	151.0	79.0	6.10	13.00	4.80	2.40	6.40	10.10	4.70	9.593	666.0	174.0	39.5	10.0
Average	191.2	146.9	76.9	5.66	14.88	3.52	2.84	6.72	9.04	3.80	8.281	649.2	189.6	38.3	9.6
Lot II, corn meal:															
Razorback	147.0	120.0	80.0	4.00	9.80	4.00	2.10	6.40	7.80	3.00	7.187	536.0	144.0	38.5	6.0
Do	104.0	81.0	77.8	3.40	7.50	4.00	1.40	4.80	7.10	3.20	2.937	528.0	150.0	34.5	5.5
Yorkshire	188.0	147.0	76.5	4.90	13.40	1.60	2.30	4.80	9.90	1.20	8.000	640.0	198.0	37.0	7.0
Razorback-Poland China	237.0	193.0	80.0	5.60	15.50	3.20	2.80	8.00	9.10	4.70	9.250	660.0	192.0	42.5	14.0
Razorback-Berkshire	148.0	117.0	79.0	3.70	10.40	3.20	2.20	6.40	9.70	2.70	6.125	522.0	174.0	34.5	5.5
Average	164.8	131.6	78.6	4.32	11.32	3.20	2.16	6.08	8.72	2.96	6.700	577.2	171.6	37.4	7.6

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

The following table has been arranged from these figures in a similar manner as the foregoing ones and for the same reasons:

Average actual and relative amounts of blood, vital organs, and internal fat of pigs fed pea meal in comparison with corn meal.[a]

	Wide ration.		Narrow ration.	
	Pounds.	*Per cent.*	*Pounds.*	*Per cent.*
Live weight	164.8	100.0	191.2	100.0
Dressed weight	131.6	78.6	146.9	76.9
Blood	4.32	2.58	5.66	2.97
Liver	2.16	1.29	2.84	1.49
Heart	.38	.23	.42	.22
Capacity of stomach[b]	8.72	5.22	9.04	4.74
Intestines	11.32	6.78	14.88	7.80
Kidneys	.475	.28	.60	.31
Spleen	.20	.12	.22	.12
Intestinal fat	2.96	1.77	3.8	1.99
Kidney fat	6.70	4.01	8.281	4.34

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

[b] The average capacity of the stomachs of the pigs in this experiment was determined "by emptying them of their natural contents and estimating the capacity of each by the number of pounds of water they would contain."—Eighteenth An. Rpt., p. 50, Wisconsin Expt. Sta.

These figures do not show quite the same uniformity in weights of vital organs as do the preceding ones. In the relative weight of hearts and capacity of stomachs, there is a slight difference in favor of the pigs on the wide ration, although the actual weights of these organs are greater in the case of the narrow-ration pigs. The ratios of body length to length of intestines, however, favored the narrow-ration lot, being 1:16.95 and 1:4.95, respectively, for the small intestine and large intestine of the pigs on pea meal, and 1:15.43 and 1:4.59, respectively, for the small intestine and large intestine of the pigs on corn meal. A large proportion of these pigs were razorbacks or razorback crosses. In this experiment there was also a greater accumulation of internal fat by the narrow-ration pigs than by those on the wide ration.

The Iowa experiments.—The pigs fed in a comparative test on wide and narrow rations at the Iowa Station were slaughtered at the close of the experiments and data compiled in the same manner as with those in the breed test. The following table shows the report of the packers on the slaughter test. It has been arranged so as to show the averages for both tests:

[End of Part II.]

Slaughter test of pigs fed on wide and narrow rations.[a]

Ration.	No. of pigs.	Dressed weight.	Melts (spleens).	Heads. Gross.	Heads. Net.	Tongues.	Cheek meat.	Cheek-meat fat.
Wide ration:		*Per cent.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	5	79.30	3.00	60.00	48.00	5.00	5.00	2.00
Second experiment	4	77.00	1.00	39.75	33.00	2.75	3.25	.75
Average per pig	--------	78.28	.44	11.08	9.00	.86	.92	.31
Narrow ration:								
First experiment	5	77.10	2.00	50.50	40.00	5.00	5.00	.50
Second experiment	4	74.10	1.00	34.75	28.50	2.50	3.00	.75
Average per pig	--------	75.77	.33	9.47	7.61	.83	.89	.14

Ration.	Leaf lard.	Kidneys.	Gullets.	Gullet fat.	Ham facings.	Plucks.	Livers.	Hearts.
Wide ration:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	40.00	2.00	5.67	0.33	4.00	31.00	15.00	4.00
Second experiment	19.00	2.25	2.50	.75	3.50	18.00	11.00	2.00
Average per pig	6.56	.47	.91	.12	.83	5.44	2.89	.67
Narrow ration:								
First experiment	41.00	2.00	5.50	.50	4.00	32.00	16.00	4.00
Second experiment	17.00	1.75	2.00	.50	1.75	16.00	11.00	1.75
Average per pig	6.44	.42	.83	.11	.64	5.33	3.00	.64

Ration.	Lungs.	Bladders.	Bladders. Gross.	Bladders. Net.	Bladder fat.	Total weight of guts.	Gut fat.	Caul and ruffle.
Wide ration:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	6.00	----------	1.50	0.50	0.50	100.00	30.00	18.00
Second experiment	5.00	0.50	----------	--------	---------	86.00	14.00	11.50
Average per pig	1.22	----------	----------	--------	---------	20.67	4.89	3.28
Narrow ration:								
First experiment	7.00	----------	1.50	.50	.50	124.00	22.00	16.00
Second experiment	3.50	.50	----------	--------	---------	90.00	7.00	10.25
Average per pig	1.17	----------	----------	--------	---------	23.78	3.22	2.92

Ration.	Bung guts. Gross.	Bung guts. Net.	Bung-gut fat.	Pig bags.	Small guts. Gross.	Small guts. Net.	Stomachs. Gross.	Stomachs. Net.
Wide ration:	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
First experiment	4.00	3.75	5.00	2.00	23.00	14.00	13.00	7.00
Second experiment	5.00	3.00	----------	1.25	14.00	8.00	8.00	5.50
Average per pig	1.00	.75	----------	.36	4.11	2.44	2.33	1.39
Narrow ration:								
First experiment	4.00	3.00	5.00	.50	24.00	12.00	13.00	6.00
Second experiment	8.75	6.00	----------	1.75	15.75	13.00	6.75	4.00
Average per pig	1.42	1.00	----------	.25	4.42	2.78	2.19	1.11

[a] Bul. No. 48, Iowa Expt. Sta.

The figures of the above table have been arranged in the following manner to show the results of the slaughter test in percentages:

Relative weights of vital organs of pigs fattened on narrow and wide rations.

Ration.	No. of pigs.	Melts (spleens).	Tongues.	Kidneys.	Gullets.	Plucks.	Livers.	Hearts.
Wide ration:		*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*
First experiment	5	0.25	0.41	0.17	0.47	2.56	1.24	0.33
Second experiment	4	.14	.39	.30	.36	2.57	1.57	.29
Average		.21	.41	.22	.43	2.57	1.36	.32
Narrow ration:								
First experiment	5	.19	.47	.19	.51	2.99	1.50	.37
Second experiment	4	.14	.37	.26	.29	2.33	1.60	.26
Average		.17	.43	.22	.43	2.73	1.54	.33

Ration.	Lungs.	Bladders.	Bladders, net.	Total weight of guts.	Bung guts, net.	Small guts, net.	Stomachs, net.	Dressed weight.
Wide ration:	*Per ct.*	*Per cent.*	*Per cent.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per cent.*	*Per ct.*
First experiment	0.50		0.04	8.26	0.31	1.16	0.58	79.3
Second experiment	.71	0.07		12.29	.43	1.14	.78	77.0
Average	.58			9.75	.35	1.15	.66	
Narrow ration:								
First experiment	.65		.05	10.65	.28	1.12	.56	77.1
Second experiment	.50	.07		13.08	.87	1.89	.58	74.1
Average	.60			12.19	.51	1.43	.57	

This table shows the same tendency that has been remarked upon for pigs on a narrow ration to show greater relative weight of vital organs than those on a wide one. In relative weight of spleens and stomachs (net), those of wide-ration pigs are heavier; in the weight of kidneys and gullets the two lots are equal, and they are very nearly equal in relative weight of hearts. The great difference existing between the relative weights of the livers of the two lots gives a considerable advantage in relative weight of plucks to the narrow-ration pigs and the lead of the narrow-ration pigs in intestines gives them larger relative total weight of guts. The wide-ration pigs dressed out the greater weight of carcass.

The following table shows, from data furnished by Swift & Co., the actual and relative amounts of lard yielded by these pigs:

Lard yield of hogs fed narrow and wide rations.

Ration.	No. of pigs.	Live weight.		Ham facings.		Heads, cheek-meat fat, gullet fat.		Leaf lard.	
		Total.	Average.	Weight.	Lard equivalent.	Weight.	Lard equivalent.	Weight.	Lard equivalent.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Wide	4	700	175	3.75	2.62	34.50	12.07	19	18.05
Narrow	4	690	172	1.75	1.31	29.75	10.41	17	16.15

Lard yield of hogs fed narrow and wide rations—Continued.

Ration.	No. of pigs.	Gut fat, caul, and ruffle fat.	Bones and tails.		Fat trimmings.		Yield of lard.		Proportion of live weight.
		Lard equivalent.	Weight.	Lard equivalent.	Weight.	Lard equivalent.	Total.	Average.	
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Per cent.*
Wide	4	14.00	24.75	4.21	37.5	28.12	79.07	19.77	11.29
Narrow	4	13.80	21.75	3.69	37	27.75	73.11	18.28	10.59

This table shows results contrary to the last two Wisconsin experiments, whereas in the foregoing pages attention was called to the fact that the pigs fed narrow rations produced in two experiments more internal fat in proportion to live weight than similarly bred pigs on a wide ration. Here it must be noted that the wide-ration pigs produced 0.76 per cent more internal fat than those on the narrow ration. A point to be observed in connection with the Iowa experiments is that there was a very much greater variety of feed given than in the Wisconsin experiments, and that so far as variety of feed was concerned the conditions were practically the same for both lots now under consideration. In the first experiment the wide-ration pigs were given, during the feeding period of one hundred and fifty-three days, fourteen different feeds and the narrow-ration lot thirteen. In the second experiment the wide-ration pigs had, during a feeding period of one hundred and sixty-four days, nine different feeds, and those on the narrow ration ten. In the Wisconsin experiments the narrow-ration pigs that showed the greatest variation in relative weights of blood and vital organs compared with those on a wide ration, in the same test, received for one hundred and twenty-six days a ration of ground pease, wheat middlings, and skim milk, while the wide-ration pigs had corn meal and skim milk. In the other experiments neither lot was given an advantage in variety and two kinds of feed to each lot was the most allowed, the same feeds being given during the entire experiment.

In discussing results the Wisconsin Station investigators[a] point out that the pigs on wide rations generally dressed a larger percentage of the live weight than those on narrow rations, but that this larger relative amount of dressed weight was made at the expense of the weight of vital organs. Conversely, the greater weight of vital organs of the narrow-ration pigs was made at the expense of the dressed weight. The following comments on the Wisconsin results are interesting:

It may be noticed that in the amount of blood, weight of intestines, and stomach, weight of livers, and weight of kidneys, the pea-fed lot has a greater average weight in every case than the corn-fed lot; and, as this is generally considered as

[a] Seventeenth An. Rpt., pp. 21–23.

comprising the most of the material making up the difference between dressed and live weight, the question naturally arises as to why there should not be a greater difference than the table shows in the average percentage of dressed meat to live weight between the two lots. This may be explained by stating that in dressing the carcasses of the two lots it was noticed that there was apparently somewhat of a "dropsical" condition in nearly all of the pigs of the corn-fed lot; i. e., there was quite a large quantity of fluid in the abdominal cavity, which was not to be found, in such quantities at least, in those fed on pease and middlings.

The following quotation suggests the possibility that long-continued feeding exclusively on a very wide ration, such as corn, may lower vitality and render the animal less able to resist disease:[a]

Further study of the table discloses the fact that this increased percentage of dressed meat to live weight is the outcome of a proportionately smaller percentage of blood and heart, kidneys, liver, spleen, stomach, intestines, and other internal organs that have to do with the vital functions of the animal. It may be that this increased percentage of dressed meat has been secured at the expense of the vitalizing forces of the animal, leaving it impoverished in those respects to a degree that may go far to explain the great prevalence of hog cholera and other diseases that are so common and so extremely fatal in those sections where the hogs are fed mainly corn.

INFLUENCE OF TANKAGE ON THE CARCASS.

When the Indiana experiments with tankage closed, 2 pigs in each lot were slaughtered and the various parts of the body weighed.[b] The expected difference in weight of vital organs of the tankage-fed hogs as compared with those fed on corn was not very apparent. A corn-fed pig weighing 182 pounds yielded 4½ pounds of blood, which was the same as that of a pig weighing 195 pounds fed the smaller tankage ration (Lot I) and only 2 ounces more than a 150-pound pig from the lot fed on corn meal, shorts, and tankage. There was no difference in either weight or length of small intestines due to feeding the highly nitrogenous feed. The pig showing the greatest length of small intestines (65 feet 4 inches) was fed on corn, the next greatest length of small intestine being 60½ feet from a tankage-fed pig. The only difference in the digestive organs that could be charged to the feed was the condition of the stomachs in the corn-fed lot. These were filled with "sour, offensive-smelling corn meal," and the contents of one of them weighed 11 pounds 4 ounces, while the next greater weight of stomach contents was 6 pounds 5 ounces, found in the case of a pig on corn meal, shorts, and tankage. This apparently sour, abnormal condition of the contents of the stomachs was not particularly marked with the tankage-fed pigs.

When the carcasses were cooled and cut up, the only appreciable difference that could be traced to the feed was a somewhat greater accumulation of internal fat in the corn-fed pigs, and the flesh was

[a] Eighteenth An. Rpt., p. 33, Wisconsin Expt. Sta.
[b] Bul. No. 90, Indiana Expt. Sta.

somewhat less firm than that of the tankage-fed carcasses. Feeding tankage did not show a marked influence on the relative amount of lean meat, but this feature was very plainly influenced by the breed. Half the pigs were Berkshires and half Poland Chinas. The Berkshire carcasses showed relatively more lean meat than the Poland China carcasses, and in every instance the depth of fat on the back was less in the carcasses of the Berkshires than in those of the Poland Chinas.

INFLUENCE OF FEED ON EXTERIOR FAT.

The preceding figures show mainly the influence of feed on the internal organs. The following show the effect of various rations as evidenced by the thickness of fat on the loin, back, and shoulders. These results were obtained at the Wisconsin Experiment Station[a] in connection with slaughter tests already noted:

Thickness of exterior fat of pigs fed wide and narrow rations.

Ration and breeding.	Loin.	Back.	Shoulder.
Corn and rye meals:	*Inches.*	*Inches.*	*Inches.*
Poland China	1.75	2.5	2.75
Yorkshire	1.37	1.5	2.25
Berkshire	1.75	2.12	2.37
Razorback-Poland China	1.75	2.5	3.00
Do	1.12	2.0	2.12
Average	1.54	2.12	2.49
Pea meal and shorts:			
Berkshire	1.25	1.62	1.75
Poland China	1.37	1.75	2.12
Razorback-Poland China	.88	1.62	2.00
Do	1.25	1.75	2.00
Average	1.16	1.68	1.96
Pea meal:			
Razorback-Berkshire	1.5	1.625	2.00
Small Yorkshire	1.375	1.875	2.75
Razorback	1.875	2.0	1.375
Razorback-Poland China	2.0	2.0	3.00
Razorback	2.25	2.375	2.75
Average	1.8	1.975	2.175
Corn meal:			
Razorback	2.0	2.125	3.00
Do	1.125	1.25	1.75
Small Yorkshire	2.125	2.125	3.00
Razorback-Poland China	3.00	2.75	3.50
Razorback-Berkshire	1.75	2.0	2.50
Average	2.0	2.05	2.55

[a] Eighteenth An. Rpt.

The following table presents the averages of the foregoing:

Average thickness of exterior fat of pigs fed wide and narrow rations.

Ration.	Loin.	Back.	Shoulder.
Wide ration:	*Inches.*	*Inches.*	*Inches.*
Corn and rye meals	1.54	2.12	2.49
Corn meal	2.00	2.05	2.55
Narrow ration:			
Pea meal and shorts	1.16	1.68	1.96
Pea meal	1.8	1.975	2.175

The influence of these rations on the exterior fat is very marked. In each case where a narrow ration was fed, the fat of the loin, back, and shoulder was less than where a wide ration was fed. To go more into details, where pea meal and shorts were fed in comparison with corn meal and rye meal, the thickness of fat on the loin, back, and shoulder was 1.16 inches, 1.68 inches, and 1.96 inches, respectively, in the pigs fed on the narrow ration; and the same measurements of the pigs fed corn meal and rye meal were 1.54 inches, 2.12 inches, and 2.49 inches, respectively. The difference in thickness of fat between the pigs fed pea meal in comparison with corn meal was not so great as in the other experiment. The thickness of loin, back, and shoulders of the pea-fed pigs was 1.8 inches, 1.975 inches, and 2.175 inches, respectively—considerably more in all cases than those measurements for the pigs on pea meal and shorts, although the nutritive ratio of the pease was less than that of the ration of pea meal and shorts. These measurements of the pigs fed corn meal were, respectively, 2 inches, 2.05 inches, and 2.55 inches. Although there was an excess over the pigs fed corn meal and rye meal, except in the thickness of fat on the back, the difference in these measurements between the pigs fed corn meal and those fed pea meal is less in all respects than the same measurements between the pigs fed corn meal and rye meal and those fed pea meal and shorts.

The respective influences of breed and feed are very well marked, as shown in the large table. As an example of the predominance of breed influence, the Yorkshire in the lot fed corn meal and rye meal and the Poland China in the lot on pea meal and shorts are interesting. The Yorkshire had a thickness of fat over loin, back, and shoulder of 1.37 inches, 1.5 inches, and 2.25 inches, respectively—considerably below the average for the lot; the Poland China in the narrow-ration lot measured 1.37 inches, 1.75 inches, and 2.12 inches, respectively, at these points—considerably above the average of the lot. On the other hand, a very interesting instance of the predominance of the influence of feed is seen in the case of the small Yorkshire in the lot fed corn meal, which measured 2.125 inches,

2.125 inches, and 3 inches, respectively, over loin, back, and shoulder, standing second in the lot in this respect and well above the average.

EFFECT OF FEED ON STRENGTH OF BONES.

In the two experiments[a], of which the foregoing results are a part, tests were made to ascertain the breaking strength of thigh and hind pastern bones and the influence of different means of feeding on this. The following results were obtained:

Breaking strength of bones.

Ration and breeding.	Thigh.	Hind pastern.
	Pounds.	*Pounds.*
Corn and rye meals:		
Poland China	930.0	232.0
Yorkshire	886.0	175.0
Berkshire	748.0	277.0
Razorback-Poland China	1,050.0	384.0
Do	727.0	204.0
Average	868.0	254.0
Corn meal:		
Razorback	456.0	234.0
Razorback	610.0	170.0
Yorkshire	720.0	248.0
Razorback-Poland China	1,027.0	273.0
Razorback-Berkshire	583.0	219.0
Average	679.2	242.0
Pea meal and shorts:		
Berkshire	816.0	274.0
Poland China	862.0	240.0
Razorback-Poland China	762.0	174.0
Do	859.0	306.0
Average	829.0	249.0
Pea meal:		
Razorback-Berkshire	642.0	375.0
Yorkshire	791.0	370.0
Razorback	793.0	360.0
Razorback-Poland China	1,260.0	343.0
Razorback	823.0	340.0
Average	861.8	357.6

These figures show a greater breaking strength of thigh and hind pastern bones in the wide-ration pigs fed on corn and rye meals than those fed otherwise. In the experiment with pea meal and corn meal, however, the breaking strength of these bones was much higher in the narrow-ration lot than in those fattened on a wide ration.

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.

Carlyle and McConnell[a] calculated the breaking strength of the bones for each 100 pounds of carcass weight, and their results are given in the following table:

Breaking strength of bones per 100 pounds carcass weight.

Ration.	Thigh.	Hind pastern.
	Pounds.	*Pounds.*
Corn and rye meals	504.0	146.0
Corn meal	530.4	180.2
Pea meal and shorts	568	169
Pea meal	579.4	245.2

When we consider the breaking strength of the bones in relation to the weight of carcass, there is a very manifest advantage in favor of the narrow ration, the bones of the pigs on pea meal alone breaking at a higher point than those of the pigs on pea meal and shorts, and the bones of the pigs on corn meal alone breaking at a higher point than those of the pigs on corn meal and rye meal.

FEEDING FOR PRIME BACON.

One of the branches of the hog industry to which it would seem profitable for farmers in the United States to pay more attention than in the past is the production of bacon for the English market. Most United States export product goes to Great Britain, and it forms the greater part of the bacon imported by that country, but it has never equaled the Danish bacon in price, and in this respect it has generally been behind the bacon imported from Canada also. While American bacon is said to have a better standing on this market at present than in former years, we can hardly yet claim superiority for it; and whatever advance in quality has been made must be attributed rather to the enterprise of the packers than to increased skill on the part of the breeder or the feeder.

Canadian farmers depend upon their exports of bacon to a very great extent, and its maintenance is a source of solicitude. Day, at the Ontario Agricultural College, and Grisdale and Shutt, at the Central Experiment Farm, have studied the production of export bacon during the past eight years to ascertain the best methods of feeding and breeding, and also the prevention of deleterious properties in the bacon produced.

REQUIREMENTS OF THE ENGLISH BACON TRADE.

At the outset of his studies Day[b] obtained data concerning the requirements of packers for the bacon exported to Great Britain.

[a] Eighteenth An. Rpt., Wisconsin Expt. Sta.
[b] An. Rpt., 1896, pp. 74–77, Ontario Agricultural College.

The following statement from J. W. Flavelle, of Toronto, an authority on this subject, explains these requirements and the qualifications of different breeds to meet them, according to the information at the time of writing:

The English market for Wiltshire sides is in a general way divided, first in relation to the fatness or leanness of a side, and second as to its size.

The most desirable hog is one which will make a side weighing from 42 pounds to 55 pounds. If it be made from a hog with the fat even down the back, and not too much of it, and a good thick belly, it will grade as No. 1 selection. If the back be too stout, with perhaps only the extra fat bowed up on the shoulder, it may go into what we call No. 2 selection. This No. 2 selection is purely regulated by the fatness of the side. If it is extra stout, it goes forward as "fat." The value of a No. 2 side fluctuates very greatly. Sometimes, when the market is in a peculiarly active condition, No. 2 sides will sell almost on a parity with No. 1. The greatest difference is from 2 to 8 shillings, with perhaps an average through the year of 4 shillings per hundredweight. Heavier sides weighing, say from 60 pounds to 70 pounds, even if lean, often bear a severe reduction in price, while if they are fat we have known the difference to reach the extreme point of 12 shillings per hundredweight, although this, of course, is a very rare case.[a]

* * * * * * *

The value of hogs, like your Chester White, Duroc Jersey, and Poland China, is largely determined by the season of the year in which they are marketed. The sections from which these come the most freely (Essex and Kent) have always catered to the dressed-hog trade and have been in the habit, prior to eighteen months ago [about 1895], of marketing their hogs almost exclusively during the winter months. These hogs were marketed at a time when the export business was the worst—the winter trade always recording lower prices in England than the summer, hence these hogs have sold for dressed-hog purposes fairly well up to desirable Wiltshire stock. We are, however, as exporters, gradually pulling away from them even in winter time, and to-day we are paying for prime lean hogs up to 200 pounds 4 cents, while for fat hogs, and hogs over 200 pounds, we are only paying 3½ cents.

Mr. Flavelle states, in reporting on the pigs of a breed test of 1896, that with the possible exception of 1 each of the Duroc Jersey, Poland China, and Chester White breeds, all the pigs of these breeds would go into the 3½-cent class. These 3 were excepted on account of being "sizable," "showing some evidence of flesh," although, strictly speaking, they would be thrown out. One Yorkshire and 2 Berkshires would go into the 3½-cent class. The Tamworths were all classed as No. 1 selection, but one was faulty from being fed too long. He advises the development of a hog for the Canadian export trade which shall be well fleshed, deep in side, with a well-proportioned ham and shoulder, and marketed at a weight of 165 to 190 pounds. Care is advised to get an animal with a good thick belly, and one that will fatten evenly on the back and carry a side very even throughout. He states that the criticism to which Canadian sides are subject on

[a] In a later report Day defines Wiltshire bacon as "made from well-fed hogs, weighing from 160 to 200 pounds live weight. 'Cumberland bacon' is made from lighter and generally leaner hogs, and the side is cut differently."—Ontario Agricultural College An. Rpt., 1898, p. 88.

English markets, when compared with Irish and Danish sides, is that the Canadian side "ran off in the loin and ham." There was too much shoulder development as compared with that of the ham.

SOFT BACON.

The greatest obstacle with which Canadian bacon curers have to contend is the tendency of the bacon to become soft in curing. The Canadian packer finds an "inordinate quantity of soft bacon" in the product of hogs purchased in May, June, and part of July.[a] The nature of this trouble, its causes and prevention, have been studied very extensively by Canadian experimenters. Day states that soft bacon does not necessarily mean fat bacon; on the contrary, softness is more likely to develop in hogs that are lean and underfed than in those that have been well fed and are fat. This statement is borne out by the report of the packer on the pigs fed in 1898 that the Cumberland sides in all lots showed more tendency to softness than the Wiltshires, although they were not of the same breed nor were they fed similarly.[b] Again the packer's report states:

It was very noticeable that the sides which turned out soft invariably belonged to hogs that were manifestly unfinished. Without exception, the backs of the soft sides were thin (usually less than three-fourths of an inch in thickness) and in general pointed not so much to lack of weight, but rather to the hogs having been marketed before they were in a marketable condition. This is also true in a wider way according to our experience. The bulk of soft sides in our house come from No. 3 and No. 4 selection, which classes comprise the light weights.[c]

Day says:[a]

Where the tenderness is barely noticeable, the bacon may still pass as No. 1 selection; when there is decided tenderness, it must go into a cheaper grade; but a really soft side is of little value.

According to Day—[a]

Softness develops while the bacon is in the salt, and when taken out of the salt the fat is soft and spongy, the value of the bacon being reduced according to the degree of softness.

According to Shutt,[d] softness is readily perceptible to the touch and visibly noticeable when firm and soft sides are hung on the hooks, the "drag" of the soft sides being much greater than that of the firm ones. Its effects are also seen when firm and soft sides are lifted from a table by either end, the firm side remaining fairly straight and the soft one doubling over.

The nature of softness.—At the Central Experimental Farm, Shutt[e] conducted exhaustive studies during two years to study the nature, cause, and prevention of softness in bacon. He found that the soft characteristic was due to the presence of a large proportion of liquid

[a] An. Rpt., 1898, p. 88, Ontario Agricultural College.
[b] An. Rpt., 1898, Ontario Agricultural College.
[c] An. Rpt., 1901, p. 59, Ontario Agricultural College.
[d] Bul. No. 38, p. 8, Central Experimental Farm.
[e] Bul. No. 38.

fats, principally olein, in the fatty tissue of the pork. Animal fats are generally composed mainly of three fatty compounds—palmitin, stearin, and olein, of which olein constitutes the greatest part of the fat of swine. Of these, palmitin and stearin are solid at ordinary temperatures, but olein is a liquid or fluid fat at ordinary temperatures, and it is readily apparent that the greater the proportion of olein in fat the softer it will be, and, conversely, the greater the proportion of palmitin and stearin the firmer the fat will be.

The fatty tissues from 2 Wiltshire sides was analyzed; one was firm and of good quality, weighing 46 pounds, and the other, weighing 44 pounds, was soft and of very inferior quality. Samples were taken by cutting into the sides immediately in front of the thigh joint (socket of the femur in the pelvic arch) and immediately in front of the first rib, this being done to offset any possible differences in the composition of the fat due to its location; the one sample was designated "loin," the other "shoulder." The following table shows the composition of fatty tissue in these samples:

Composition of fatty tissue in firm and soft bacon. (*Shutt.*)

	Firm.		Soft.	
	Loin.	Shoulder.	Loin.	Shoulder.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Water	15.56	6.53	12.50	2.67
Salt	2.73	1.12	1.84	.48
Nitrogen	.504	.285	.243	.142
Fiber (nitrogenous matter)	3.15	1.78	1.52	.89
Fat	78.56	90.57	84.27	95.96
Olein in bacon	50.05	58.33	66.37	76.94
Palmitin and stearin in bacon	28.51	52.24	17.90	19.02

The term "olein" used in these experiments includes not only olein, but all fluid fats present in the fatty tissue of the pork analyzed. As the final effect of all fluid fats on the consistency of the fatty tissue was held to be similar, this method rendered the calculations much less complex. To show the relative amounts of fluid to solid fats, the pure fats were analyzed and the ratio of solid to fluid fats calculated, with the results shown in the following table:

Composition of fat from firm and soft bacon. (*Shutt.*)

	Firm.		Soft.	
	Loin.	Shoulder.	Loin.	Shoulder.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Olein (calculated)	63.71	64.40	79.95	80.18
Palmitin and stearin	36.29	35.60	20.05	19.82
Ratio of palmitin and stearin to olein	1:1.76	1:1.80	1:3.99	1:4.02

These figures show a much larger percentage of olein in the firm pork than in the soft, being about 64 per cent in the former and 80 per cent in the latter. The greater amount of olein in the soft pork is accompanied by a corresponding decrease in the relative amount of palmitin and stearin present. The proportion of the solid to fluid fats was about 1:1.78 in the firm side and 1:4 in the soft side. Shutt[a] ascribes the cause of soft pork to this large proportion of fluid fats, and uses the estimation of the olein as "a ready means of tracing the effect of any particular food or condition on the pork produced."

The following table shows physical and chemical constants of the fat from firm and soft bacon:

Physical and chemical constants of fat from firm and soft bacon. (Shutt.)

	Firm.		Soft.	
	Loin.	Shoulder.	Loin.	Shoulder.
Melting point	37.6° C.	37.75° C.	27.4° C.	28.2° C.
Specific gravity at 96° C	.8668	.8859	.8678	.8740
Specific gravity at 100° F	.9009	.8980	.8970	.8988
Saponification equivalent	285.3	282.3	287.3	286
Reichert number	.408	.714	.408	.663
Iodine absorbed	55.3	55.9	69.4	69.6

Standards of firmness.—As no investigation of this nature could be carried on without standards of excellence for the bacon analyzed, a tentative scale was agreed upon. A factory standard was adopted ranging from 100 downward. The quality of the bacon was determined by feeling and running the finger down the fat surface of the back of a cut side, the "hardest and most resistant to pressure" being rated at 100.[b] Oiliness was particularly noted, and it is stated that "there were but few cases in which the softness (slight resistance to pressure) was not accompanied with this quality."[c] Thickness of fat and shape of carcass were also considered in making the factory ratings. The factory scale was as follows:

Very firm	85 to 100
Firm	75 to 85
Moderately firm	70 to 75
Soft	50 to 70
Very soft	less than 50

There were many objections to the use of the factory rating as the sole means of determining the amount of softness. The ratings were not so accurate, for many reasons, as was desired. The element of error in calculation, the effect of low temperatures in winter (when artificial refrigeration is unnecessary at Ottawa), making the pork appear firmer than it really was, and of high temperatures in sum-

[a] Bul. No. 38, p. 9, Central Experimental Farm.
[b] Bul. No. 38, p. 11, Central Experimental Farm.
[c] Loc. cit.

mer, making the bacon appear softer than it really was, led to the use of the olein content as the principal means of rating the softness of the pork. Unless the greatest care is taken in making the factory ratings, Shutt regards them "of little save corroborative value."[a]

The approximate percentages of olein corresponding to the factory ratings are given as follows:

	Percentage of olein.
Very firm	68 or less
Firm	68 to 71
Moderately firm	71 to 73
Soft	73 to 75
Very soft	75 and above

The greater accuracy of the olein content as the indicator of softness is shown by the fact that on factory inspection carcasses were frequently rated as "very firm" and "firm" that were shown by the olein content to be "soft" and "very soft." On the other hand, very few carcasses were rated lower by the factory inspection than by the determination of olein present.[b] In his discussion of the second series of experiments, Shutt states that "very frequently examination after smoking the bacon has confirmed the lower olein values."[c]

THE CAUSE OF SOFT PORK.

There have been many theories as to the cause of soft pork. It has been ascribed to breed, feed, age of the pig, the exercise allowed, the section of the country in which the pig is raised, the season of the year when slaughtered, etc. Shutt[b] states:

> Many theories have been advanced to account for softness in pork. Some have ascribed it to the character of the food, others to undue forcing of the pig in the earlier stages of growth, to killing the pig while in heat, to slaughtering while still immature, or unripe, to the breed of the pig, to the locality or district in which the pig is grown, and even the phase of the moon when the pig is slaughtered has been assigned as a cause.

Of all these influences, the ones that have been especially investigated have been maturity of the animals, the character of the feed and its methods of preparation, exercise, locality where produced, and breed.

Day's[d] investigations soon showed that the influence of breed was of little or no consequence. Firm bacon from pigs of the lard type and soft bacon from pigs of the bacon type showed that, so far as the firmness of bacon was concerned, methods of feeding and manage-

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[a] Bul. No. 38, p. 11, Central Experimental Farm.

[b] Bul. No. 38, p. 12, Central Experimental Farm.

[c] Bul. No. 38, p. 32, Central Experimental Farm.

[d] The reader should observe that the relative firmness of a side of bacon has little or nothing to do with the relative amount of lean meat and fat. The latter factor is undoubtedly the result of breed influence to some extent.

ment were of more importance than the question of breed. Experimenters studying the causes of soft pork are therefore disregarding the breed question to a certain extent and are only taking pains to select animals that are of pronounced bacon type. At the Ontario Agricultural College, Day fed pigs on various rations to study the effect of feed and exercise on the firmness of bacon.

At the Central Experimental Farm, Shutt's investigations covered two years. In the first year's work, about 180 Tamworth or Tamworth grade pigs were fed, the experiment commencing in May, 1899, when the pigs were one to two months old, and closing May 28, 1900. The work of this year was devoted to the effect of character and preparation of feed and methods of feeding, maturity at slaughtering, exercise, and locality where raised. Twenty lots were fed, in six of which the feeding was divided into two periods, the first period including the feeding until the pigs had attained a weight of 100 pounds and the second period included feeding after that weight. This was done to ascertain the effects of different rations at various stages of growth, as it was thought that feeding in the earlier stages a ration that was supposed to have a beneficial effect might mitigate the effects during the latter part of the fattening of one that was known to be injurious, and, conversely, to ascertain whether a beneficial ration fed to pigs during the latter stages of the experiment would offset the injurious effect of an earlier feed. This was proceeding on the theory that Day used when he fed pigs skim milk up to a weight of about 100 pounds, or allowed exercise, and discontinued such treatment after attaining this weight, and vice versa. The methods of studying the effects of immaturity and the results therefrom have already been given. To study the effects of exercise, the animals on each ration were divided into two lots, one being "in small paddocks containing shanties or shelters," the other "in a pen of the piggery, each pen having a small yard attached." To study the effect of locality on quality of bacon, half the pigs on all but three rations were from western Ontario (Essex and Kent counties) whence packers claimed to receive most of their soft bacon, and half were from eastern Ontario (Carleton County).

Each ration was given in both "limited" and "unlimited" amounts. "Where not otherwise stated, a sufficiency of green fodder, usually pease and oats, in addition to the grain ration, was given to keep the animals in a thrifty condition." This was done because it was generally recognized that these feeds induced a thrifty growth and that thrift during life has much to do with the quality of the bacon.

INFLUENCE OF MATURITY ON FIRMNESS OF BACON.

Day's conclusions on the influence of maturity on the firmness of bacon have been already referred to. Shutt's results on this phase of

the subject follow. (See p. 208.) During the preliminary investigations 4 pigs that had been weaned but a short time were killed and the olein content and melting point ascertained. The following table shows these results:

Immature pork—composition and melting point. (*Shutt.*) [a]

Locality.	Dressed weight.	Olein.		Ratio of palmitin and stearin to olein.		Melting point.	
		Shoulder.	Loin.	Shoulder.	Loin.	Shoulder.	Loin.
	Pounds.	*Per cent.*	*Per cent.*			° *C.*	° *C.*
Western Ontario	27	90.6	88.2	1:9.6	1:7.5	25.2	24.4
Do	23	86.9	85.9	1:6.5	1:6.1	24.5	25.7
Eastern Ontario	42	83.3	82.2	1:4.9	1:4.6	27.6	28.5
Do	30	73.3	72.9	1:2.7	1:2.7	29.8	32.0

[a] Bul. No. 38, p. 10, Central Experimental Farm.

Comparing these results with those of the firm pork (p. 209), this immature pork is seen to be much higher in olein content, the ratio of palmitin and stearin to olein less, and the melting point lower. It was regarded as noteworthy that the showing of the pigs from eastern Ontario was much better than those from the western counties.

As one phase of his work in 1899, the first year of his investigations, Shutt killed 2 pigs in each lot when they had attained a weight of 100 pounds and examined them for olein content and melting point of fat, thus obtaining more complete data on the effect of immaturity on the firmness of the bacon produced. "Maturity" was considered to be a weight of 175 to 200 pounds. The following table shows these results:

Relative amount of olein [a] *in fat of immature pigs.* (*Shutt.*) [b]

Ration.	Eastern.	Western.	Mean.
	Per cent.	*Per cent.*	*Per cent.*
Corn meal ½, oats, pease, and barley equal parts ½; boiled; unlimited	[c] 77.1	[c] 91.6	84.3
Corn meal, oats ½, pease, and barley equal parts ½; boiled; limited	79.2	----------	----------
Corn meal ½, oats, pease, and barley equal parts ½; dry; unlimited	83	87.1	85
Corn meal ½, oats, pease, and barley equal parts ½; dry; limited	75	83.5	79.3
Corn meal; dry; unlimited	87.2	85.6	86.4
Oats, pease, and barley, equal parts; dry; unlimited	80.9	83.6	82.1
Corn meal; soaked; unlimited	85.7	88.4	87
Oats, pease, and barley, equal parts; soaked; unlimited	71.9	77	74.4
Beans 1 part, shorts ⅘ part	[c] 83.9	----------	----------

[a] As the fat from shoulder and loin differed so little in olein content, the results of the analyses of the fat from these points were averaged.
[b] Bul. No. 38, p. 16, Central Experimental Farm.
[c] One pig only.

These results also show much higher figures for young pigs than have already been noted as characteristic of firm pork. The difference is very pronounced. The analysis of firm bacon gave the relative

amount of olein as about 64 per cent. Here the smallest amount of olein is 71.9 per cent in the case of eastern Ontario pigs which were fed an unlimited ration of equal parts of oats, pease, and barley, soaked. The high olein content of the pigs fed corn and beans should be noted, as should also that of the pigs from western Ontario. Shutt[a] regards these results as furnishing "undoubted proof of the soft character of the fat of young pigs."

INFLUENCE OF FEED AND MANAGEMENT ON THE FIRMNESS OF BACON.

RESULTS AT GUELPH.

The following table shows Day's[b] results in studying, in 1898, the influence of feed and management on the firmness of bacon. It includes results with pigs on various feeds and fed under various conditions. The factors studied were the kind of feed, method of feeding, and exercise. The pigs in the first three groups were purchased in September, and had been running on a stubble field for about six weeks. Groups IV, V, and VI were kept in pens from the time of weaning. The pigs of the last three lots were purebreds that had been in an experiment designed to show the effects of whey and exercise. After the pigs were slaughtered, packing-house inspections of the bacon were made, and these reports are included in the last column of the following table:

Condition of bacon produced by various methods of feeding.

Description of groups and methods of feeding.	Condition of bacon.
Group I: 8 sides. Hogs had been running on stubble fields. Average weight at commencement of experiment, 118 pounds. Fed six weeks on corn meal and rape.	Wiltshires: 8 sides firm.
Group II: 8 sides. Same previous treatment as Group I. Average weight at beginning of experiment, 107 pounds. Fed six weeks on corn meal.	Wiltshires: 6 sides firm. Cumberlands: 2 sides firm.
Group III: 8 sides. Same previous treatment as Group I. Average weight at beginning of experiment, 104 pounds. Fed six weeks on pease, barley, and shorts.	Wiltshires: 4 sides firm. Cumberlands: 2 sides firm, 2 sides tender.
Group IV: 8 sides. Hogs had no outdoor exercise from time of weaning. Previous to experiment were fed wheat middlings and shorts, with skimmed milk. Average weight at beginning of experiment, 100 pounds. Fed six weeks on pease, barley, and shorts, with rape.	Wiltshires: 2 sides firm, 2 sides showing very slight indications of tenderness. Cumberlands: 2 sides firm, 2 sides soft.
Group V: 8 sides. Same treatment previous to experiment as Group IV. Average weight at beginning of experiment, 94 pounds. Fed six weeks on corn meal.	Wiltshires: 2 sides firm. Cumberlands: 6 sides firm.
Group VI: 6 sides. Same treatment previous to experiment as Group IV. Average weight at beginning of experiment, 107 pounds. Fed six weeks on pease, barley, and shorts.	Wiltshires: 2 sides firm. Cumberlands: 4 sides firm.

[a] Bul. No. 38, p. 17, Central Experimental Farm.
[b] An. Rpt., 1898, Ontario Agricultural College.

Condition of bacon produced by various methods of feeding—Continued.

Description of groups and methods of feeding.	Condition of bacon.
Group A: 24 sides. Purebred hogs, comprising 2 hogs of each of six different breeds. Purchased when from seven to nine weeks old. Kept in pens with small outside yards. Fed wheat middlings until August 19; shorts and barley until September 12; pease, barley, and shorts until October 24.	Wiltshires: 4 sides firm, 2 sides showing indication to tenderness, 2 sides tender, 2 sides soft. Cumberlands: 4 sides firm, 8 sides tender to soft.
Group B: 24 sides. Same as Group A. Same treatment and same meal ration as Group A, but fed whey with meal ration.	Wiltshires: 20 sides firm. Cumberlands: 2 sides firm, 2 sides tender.
Group C: 22 sides. Same as Group A. Hogs were allowed to run in a half-acre lot during whole of experiment. Lot furnished some grass until about the middle of August. Fed the same ration as Group A.	Wiltshires: 10 sides firm, 2 sides very slightly tender. Cumberlands: 2 sides firm, 8 sides tender to soft. Quality of Group C much superior to that of Group A as regards firmness.

In discussing this table, Day calls attention to the condition of the bacon from the first three groups. These were the pigs that had had an abundance of exercise before feeding proper commenced. One lot had corn meal and rape, another corn meal only, and the third a mixed ration of pease, barley, and shorts. Yet the "only tenderness developed in the group fed on pease, barley, and shorts." With the pigs that had had no exercise after weaning (Groups IV, V, and VI) except what they obtained in the pens, the only tenderness in the bacon was in the pigs fed pease, barley, and shorts with rape. The cause of this is not apparent, as the lot on corn meal and rape made firm bacon. The suggestion is made that the lack of exercise may have had this result.

The condition of the bacon from Group B, as compared with Groups C and A, is particularly striking. It is pointed out that, although the pigs of Group B were closely confined, they made firmer bacon than those of Group C, which had an abundance of exercise and very much firmer bacon than those of Group A, which had moderate exercise. The difference is ascribed to the whey fed. The beneficial influence of dairy by-products in bacon production is seen when Groups IV, V, and VI are compared with Group A. These pigs had a ration of grain and skim milk prior to the beginning of the experimental feeding.

The influence of immaturity is seen in the larger proportion of soft sides in the Cumberlands than in the Wiltshires.

Influence of corn on bacon.—The effect of corn feeding in this experiment is decidedly unusual. Generally corn, when fed in large amounts, has produced undesirable bacon. The best results have come from mixed rations, in which barley was prominent. In a later experiment, Day[a] compared the bacon from pigs fed on corn, on

[a] An. Rpt., 1899, p. 81, Ontario Agricultural College.

pease and middlings, on barley, and on barley and rape. The packer reported on them as follows:

Lot I (corn): Very soft, fat, pasty, and greasy, and in every way undesirable. The hogs in this lot seem to have thrived well on the feed, as the sides are well finished, indeed quite fat.

Lot II (pease and middlings): Excellent quality, firm.

Lot III (barley): Very firm, probably the most distinctly hard and firm of any of the lots.

Lot IV (barley and rape): Good quality, firm, with a slight tendency, but very slight, toward tenderness.

The influence of barley on bacon.—Later experiments confirmed the evidence in favor of the use of barley for pigs. In 1900[a] several experiments were conducted with the end in view of comparing the effect of various feeds on the carcass.

In one experiment "the meal ration was as follows: Thirty-one days, 2 parts ground grain to 1 part middlings; forty-one days, 3 parts ground grain to 1 part middlings; remainder of time, or sixty-nine days, ground grain alone. The grain for one group consisted of equal parts of barley and corn, and for the other groups equal parts of barley and oats." The bacon made from these pigs was firm.

In another experiment barley and corn were compared. There were two lots of purebred pigs and they were fed as follows: "Twenty-four days, 1 part grain to 3 parts middlings; thirty-seven days, equal parts grain and middlings; remainder of time, or seventy-nine days, 3 parts grain to 1 of middlings." The bacon from 6 of the 7 hogs on barley and middlings was firm enough for No. 1 selection, 1 pig producing bacon too tender. None of the corn-fed pigs produced bacon firm enough for No. 1 selection.

Influence of roots on bacon.—Three lots of 5 pigs each were fed on meal alone, on meal and raw roots, and on meal and boiled roots. The meal that was fed was ground barley and middlings, and the test lasted one hundred and forty-one days, the meal consisting of 2 parts barley and 1 part middlings at first and changing gradually to clear barley, in the same manner as the pigs in the experiment with barley and corn and barley and oats in the preceding section. The ratio of meal to roots was about 1:1. The roots were discontinued three weeks before shipping the pigs to the packing house. The packer's report showed that all the bacon turned out firm.[a]

In another experiment 11 grade pigs that had been on roots, kitchen refuse, and mixed meal up to a weight of 120 pounds were fed meal and pulped mangels at the rate of 50 pounds of mangels to 22 pounds of meal for sixty-one days. The meal and mangels were mixed the day before feeding. The meal was 2 parts ground barley and 1 part of a mixture of bran and middlings. In this case the roots were fed up to

[a] An. Rpt., 1900, Ontario Agricultural College.

the date of shipping without deleterious results, as all of the bacon cured in firm condition.[a]

In the succeeding year raw pulped mangels were fed in rations of barley and middlings and of corn and middlings in about equal weight to that of meal fed. The feeding records of these experiments have already been reviewed. (See pp. 165–167.)

The following report of the packer shows that roots had no deleterious effect on the bacon:[b]

Barley and middlings: Eight sides, 2 of which were soft, the others grade as No. 1 sides, although there was noticeable in all a very slight tendency to pastiness.

Barley, middlings, and roots: Eight sides, 2 sides soft, 2 sides grading No. 2 (fat). The other 4 sides were very firm.

Corn and middlings: Ten sides; 4 sides tender, i. e., showing softness, but not so soft as to be excluded from No. 1 sides, 2 No. 2. The rest grade as No. 1 sides, although the class as a whole inclines to slight pastiness.

Corn, middlings, and roots: Ten sides, 4 sides soft, 2 grade as No. 2 sides. The balance were very firm.

RESULTS AT OTTAWA.

Grisdale[c] reports experiments at the Central Experimental Farm which were planned to determine the causes of soft pork, and found that the use of mixed rations generally gave the best results. In his first experiment one lot received a mixture of equal parts by measure of ground barley, rye, wheat, and wheat bran; a second, ground wheat, and a third ground buckwheat. All grain was soaked in cold water for an average period of thirty hours. The report of the packers was favorable to the carcasses of the mixed-ration lot, both immediately after cooling and when cured, the wheat-fed lot ranked second and that fed on buckwheat was least desirable. Some sides, however, were soft in the mixed-ration lot and some from the others were firm.

To determine still further the effect of wheat or buckwheat in the ration on the quality of the finished product, one lot was fed a mixture of equal parts by measure of ground barley, rye, wheat, and wheat bran, two on a ration composed of equal parts by weight of this mixture and ground wheat, while the other lot had a similar ration, buckwheat replacing the wheat. All meal was soaked thirty hours in cold water. The buyer and curer reported no difference in the quality of the pork from these lots, from which it would seem that feeding a mixed ration will produce a better quality of bacon than feeding a single grain. This conclusion is also borne out by the results of the feeding of 44 hogs with various rations—single grains, mixtures, with and without milk, dry and soaked, whole and ground. The report of the packer pointed to the value of milk in connection with a single grain, such as corn, and the beneficial effect of a mixture of grains, especially when one of them was barley.

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[a] An. Rpt., 1900, Ontario Agricultural College.
[b] An. Rpt., 1901, Ontario Agricultural College.
[c] Bul. No. 33, Central Experimental Farm.

CHEMICAL STUDIES AT OTTAWA.

FIRST SERIES OF EXPERIMENTS.—The following table shows Shutt's[a] averages of results during the first series of tests. The table shows the composition of the ration, the olein content, and the melting point of fat, the averages of these determinations for fat from loin and shoulder being given, as there was found to be very little difference in the characteristics of the fatty tissues from these points in these respects. The rations are arranged from above downward in order of olein content, those showing the least olein in the fat examined being at the top of the table and those showing most olein at the bottom.

It is stated that, as a rule, each pen contained 16 pigs at the start.

Effect of various rations on softness of pork.

[Averages from determinations of first series, 1899. (Shutt.)]

Ration.	Composition of ration.	Olein.	Melting point.
		Per cent.	°*C.*
F	Oats, pease, and barley, equal parts, soaked, unlimited	67.2	35.6
D	Oats, pease, and barley, equal parts, dry, unlimited	67.5	34.2
B	Corn meal ½, oats, pease, and barley equal parts ½, dry, unlimited	71.1	34.4
A	Corn meal ½, oats, pease, and barley equal parts ½, boiled, unlimited	72.7	33.6
B′	Corn meal ½, oats, pease, and barley equal parts ½, dry, limited	73.1	33.1
M	First period: Oats, pease, and barley, equal parts, soaked Second period: Corn meal, soaked	73.4	32.5
N	Corn meal ½, oats, pease, and barley equal parts ½, dry, limited	73.7	30.5
K	First period: Oats, pease, and barley equal parts, unlimited Second period: Corn meal, dry, unlimited	74.3	32.4
O	Corn meal ½, oats, pease, and barley equal parts ½, mangels	74.9	31.7
I	First period: Corn meal ½, oats, pease, and barley equal parts ½, dry, unlimited. Second period: Corn meal, dry	75.4	32.4
A′	Corn meal ½, oats, pease, and barley equal parts ½, boiled, limited	75.9	33.6
P	Corn meal ½, oats, pease, and barley equal parts ½, steamed clover	76.1	32.1
L	First period: Corn meal, soaked Second period: Oats, pease, and barley, equal parts, soaked	76.4	32.3
I′	First period: Corn meal ½, oats, pease, and barley equal parts ½, dry, limited. Second period: Corn meal, dry, limited	78.1	31.8
H	First period: Corn meal ½, oats, pease, and barley equal parts ½, boiled, unlimited. Second period: Corn meal, boiled, unlimited	77.9	33.0
J	First period: Corn meal, dry, unlimited Second period: Oats, pease, and barley, equal parts, dry, unlimited	78.8	31.3
H′	First period: Corn meal ½, oats, pease, and barley equal parts ½, boiled, limited. Second period: Corn meal, boiled, limited	80.0	30.2
G	Beans 1 part, shorts ¾ part	84.7	31.0
C	Corn meal, dry, unlimited	92.0	[b] 30.9
E	Corn meal, soaked, unlimited	92.4	27.7

[a] Bul. No. 38, p. 15, Central Experimental Farm.
[b] Melting point average on 2 pigs only, as the fat of the others was so soft that the melting point could not be determined.

The effect of feed.—The most striking feature of these results is the good showing of a ration of equal parts of oats, pease, and barley. They were the only ration that produced pork with a sufficiently small amount of olein in the average to rank as "very firm." The carcasses from these pigs were generally firm and even in fat, the fat having a uniform thickness of about $1\frac{1}{4}$ inches. Growth was continuous and normal. The figures bear out Day's testimony in favor of a ration composed partly of barley, and the general advantage in feeding mixed rations is borne out by these results.

Corn-belt pork producers will be particularly interested in the results of the rations in which corn formed a considerable part. In rations B, A, and B′ it constituted half the grain that was fed, yet the olein content of the fat was 71.1 per cent with ration B and 73.7 per cent in the case of ration B′—not enough to prevent any of the carcasses of these three lots from averaging "firm." When corn meal was fed exclusively during one period of growth, a mixed ration being fed during the remaining time, better results were obtained where it was fed during the closing period than where it was fed during the first period, but the mitigating effect of a mixed ration following corn meal, during the early stages of the pig's growth, may be seen by comparing rations L and J with rations C and E. The olein content of these was 76.4 per cent and 78.8 per cent, respectively, with the former rations, and 92 per cent and 92.4 per cent, respectively, with the latter. However, Shutt[a] says: "Nevertheless, our data show conclusively that when the animal is fed to a weight of 100 pounds on corn exclusively, the corrective action of such an excellent ration as oats, pease, and barley is not sufficient to render the fat firm." He also mentions the oiliness of the fat from the pigs fed corn meal alone during the finishing period, which prevented the bacon from taking rank as first quality, although the fat averaged 3.5 per cent less olein than that from the pigs on corn during the first period.[b] The disadvantage of feeding corn meal exclusively during the entire feeding period, not only because of its effect on the quality of the bacon, but on account of its effect on the growth of the pigs, is very strongly emphasized. The olein content and melting point of the fat from these pigs was the lowest of any of the lots. In addition, it is stated that the pigs made very unsatisfactory growth. Few had reached a weight of 100 pounds at the age of seven months, and some scarcely exceeded that weight at eleven or twelve months; only 5 weighed more than 170 pounds when the experiment closed. The olein content of the fat was greatest in the "finished" pigs, the animals showing marked uniformity in this respect.[c] The packing-house inspection rated as "very soft" twenty-three of the carcasses fed on

[a] Bul. No. 38, p. 24, Central Experimental Farm.
[b] Bul. No. 38, p. 25, Central Experimental Farm.
[c] Idem, p. 19.

corn meal alone, and one as "soft." The meager and uneven covering of fat, its oily character, and the stunted appearance of many of the carcasses was particularly remarked upon. "In many instances the melting point could not be taken, owing to the fluidity of the fat."

The effect of a ration made up largely of beans is somewhat surprising. While the percentage of olein was considerably less and the melting point higher, the feeding value of this ration was quite similar to that of a straight corn ration, the growth being very unsatisfactory and the carcass lightly covered with fat that was very oily.[a]

Shutt calls attention to the rise in the percentage of olein when mangels were fed, but thinks this is "perhaps not to a degree sufficient to warrant any statement as to their effect on the pork." He states further: "Steamed clover, however, appeared to notably increase the olein. Very few of the carcasses from these rations fall into the classes of 'firm' and 'moderately firm,' the influences of the corn (forming half the grain ration) being apparent."

Effect of different conditions of feeding.—As already mentioned, these experiments considered not only the effect of the different feeds given, but the conditions under which they were fed. Those investigated were "the condition of the grain (soaked or dry), the locality or district in which the pigs were littered, and the amount of exercise obtainable." The plan of the experiments to study these conditions was outlined on page 212. The pigs fed rations N, O, and P were eastern Ontario pigs, and hence were not included in the following deductions; neither were the immature animals. The following is quoted:

Boiled as against dry grain.—In the sets of experiments A and B, half corn meal and half oats, pease, and barley, boiled and dry, and I and H, first period, half corn meal and half oats, pease, and barley, boiled and dry, we find that the fat produced from the boiled grain in each case was the softer. In A and B the difference was 2.2 per cent olein, and in I and H the difference was 2.3 per cent olein.

Soaked as against dry grain.—This comparison was made with corn meal (C and E), a mixture of oats, pease, and barley (D and F), with rations employing during the first period corn meal, and second period oats, pease, and barley (J and H), and lastly, first period, oats, pease, and barley; second period, corn meal (K and M). The results are:

Percentages of olein.

	C and E.	D and F.	J and H.	K and M.
Soaked	92.5	67.2	76.4	73.5
Dry	92.1	67.7	78.8	74.4

We scarcely feel justified from these data in drawing any conclusions as to the relative effect on firmness of the same grain ration, fed soaked or dry. A study

[a] Bul. No. 38, p. 22, Central Experimental Farm.

of the individual results does not reveal any definite tendency, and most probably the condition of the grain in this respect has but little, if any, effect on the quality of the pork.

Eastern origin as against western.—This feature was allowed for under all the rations tested.[a] The averages are in the order as discussed.

Percentages of olein.

	A and B.	C and E.	D and F.	I and H.	J and L.	K and M.
Eastern origin	73.4	91.2	67.9	78.6	76.4	74.4
Western origin	73.0	93.4	67.0	77.2	78.9	73.4

In four cases out of six, the olein of the eastern pigs is somewhat the greater, and taken together the averages give a total excess of 3.7 per cent olein over the corresponding western groups. In two cases the western pigs show the larger olein per cent, amounting to 4.7 per cent olein over the corresponding eastern groups. These facts do not warrant us in supposing that there is any marked tendency toward softness in finished pigs due simply to western origin, as is thought by some packers. If finished pigs from the western part of Ontario are softer than those from the eastern, it must be due to the character of the feed they obtain.

Inside as against outside.—As already explained, the pigs denoted as "inside" are held to have had opportunities for limited exercise only—that is, in the small yards attached to the pens of the piggery; the "outside" pigs had the run of an inclosure in which there was a movable sty or shelter for their accommodation at night.

The averages are as follows:

Percentages of olein.

	A and B.	C and E.	D and F.	I and H.	J and L.	K and M.
Inside	71.9	92.3	67.0	77.8	76.5	73.0
Outside	74.5	92.3	67.9	77.9	78.7	74.8

In several of these instances it will be seen the results are practically identical (for differences of less than 1 per cent must not be considered as forming a sufficiently strong basis from which to draw conclusions); in the other cases, the larger amount of olein appears in the fat of the "outside" pigs. There can be no doubt as to the value of a sufficiently large run for young and growing pigs; exercise to a limited extent in the earlier period of an animal's life is essential to a strong and thrifty growth, to good digestion and assimilation of the food.

We therefore do not think it wise, without further evidence, to draw the conclusion that the larger area of exercise had any injurious effects on the quality of the pork. Indeed, a survey of the two seasons' results makes it very clear that the character of the food is the one great influencing factor, and that the varying features or conditions, other than the ration, had very little to do with the relative firmness of the resulting fat.[b]

SECOND SERIES OF EXPERIMENTS.—In 1900 a second series of experiments was begun. All features relating to the effects of maturity

[a] Except rations N, O, and P.—G. M. R.

[b] Bul. No. 38, pp. 26, 27, Central Experimental Farm.

and conditions of feeding were discontinued, because the bad effects of immaturity were regarded as proved, and the effects of conditions, such as boiling and soaking feed, origin, amount of ration and exercise, were regarded as of little importance. Many rations were duplicates of those of the preceding series and, in addition, the influences of skim milk and various succulent feeds were studied from various standpoints, as was also that of a ration of pease alone. As there had previously been found to be no important difference between the olein contents of the fatty tissue from the loin and the shoulder, the samples were taken from the shoulder only in this series of tests.

The following table shows the averages of this series of experiments, arranged in the same manner as the preceding one·

Effect of various rations on softness of pork.

[Averages from determinations of second series, 1900. (Shutt.)]

Ration.	Composition of ration.	Olein.	Melting point.
		Per cent.	*°C.*
17 C	Corn meal ½, oats, pease, and barley, equal parts ½, skim milk and sugar beets	66.9	32.3
4	Pease	67.2	32.5
17 B	Corn meal ½, oats, pease, and barley, equal parts ½, skim milk and mangels	68.2	32.7
1	Oats, pease, and barley, equal parts	68.7	32.4
17 A	Corn meal ½, oats, pease, and barley, equal parts ½, skim milk and turnips	70.4	32.3
3	Corn meal and skim milk	70.9	33.3
7	Corn meal ½, oats, pease, and barley, equal parts ½, and skim milk	72.3	31.1
13	Corn meal ½, oats, pease, and barley, equal parts ½; from October 16, ½ corn meal, ½ pease	72.3	31.2
12	Corn meal ½, oats, pease, and barley, equal parts ½, and cooked pumpkins	73.3	31.4
14	Corn meal ½, oats, pease, barley ½, and artichokes	73.4	31.5
9	First period: Oats, pease, and barley, equal parts. Second period: Corn meal	73.9	31.1
11	First period: Pastured on rape; corn meal ½, oats, pease, and barley, equal parts ½. Second period: Raw pumpkins and same grain	74.2	31.6
6	Corn meal ½, oats, pease, and barley, equal parts ½	74.6	30.3
10	Pastured first on rape, finally on artichokes; corn meal ½, oats, pease, and barley, equal parts ½	74.9	31.4
16	First period: Corn meal. Second period: Oats, pease, and barley, equal parts	76.1	30.9
15	Pastured on clover; from October 30, fed clover; corn meal ½, oats, pease, and barley, equal parts ½	76.1	30.3
8	First period: Corn meal ½, oats, pease, and barley, equal parts ½. Second period: Corn meal	77.9	30.8
2	Corn meal only	83.6	28.6
5	Beans	84.9	29.5

The remarkable feature of these results is the good showing made by a ration in which skim milk formed a considerable part. Although corn meal made up half the amount of grain fed, the addition of

skim milk and sugar beets gave this ration the firmest pork in the experiment. Rations A and B in the first series, which were the same without milk and roots, gave an average olein content of 73.2 per cent, which would grade the bacon as "soft," whereas the bacon from ration 17 C gave an olein content of only 66.9 per cent, grading "very firm." Shutt[a] is evidently not prepared to attribute a great amount of this difference to the use of succulent feeds, but rather regards the presence of roots as not detrimental. As ration 17 B in the second series and ration O in the first were identical, and as there was a difference of 6.7 per cent in olein content in favor of the skim milk ration, there are good grounds for attributing the greater influence to skim milk. The most remarkable corrective influence of this dairy by-product is seen when ration 3 (corn meal and skim milk) is compared with ration 2 (corn meal only). The advantage in olein content is 12.7 per cent in favor of the skim milk. Comparing rations 7 and 6, the corrective influence of skim milk when fed in a mixed grain ration is seen to be less than when corn meal alone makes up the grain of the ration. This result is similar to those obtained when studying the rate and economy of gain from various rations, and it would seem to indicate that variety in the ration is important as regards the firmness of the pork produced. These results show the same advantages in favor of feeding corn meal during the finishing period and mixed grain in the earlier stages, rather than feeding corn meal during the earlier months of life. (Compare rations 9 and 16.)

From the showing of the lots on roots, etc., Shutt[b] concludes that "rape, pumpkins, artichokes, sugar beets, turnips, and mangels can be fed in conjunction with a good ration without injuring the quality of the pork." With clover, however, he found a higher olein content than where no clover was fed, the percentage of olein being 76.1 in the first instance and 74.6 in the latter. (Compare rations 6 and 15.) He regards the fact that 76.1 per cent was the olein content of the pigs on ration P in the first series, which contained steamed clover, as emphasizing this opinion. The pigs on succulent feed showed a tendency to become too fat, particularly in the case of ration 10, where they had rape and artichokes.

A ration of equal parts of oats, pease, and barley proved very valuable, as in the first series; pease alone proved to have a very high feeding value, which was contrary to Day's experience but in line with that of the Wisconsin results. However, Day has found pease to produce a firm quality of bacon, but objects to them as a single feed for pigs, as his results do not show good gains with them alone. Beans again proved to be undesirable when fed without corrective feeds.

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[a] Bul. No. 38, p. 30, Central Experimental Farm.
[b] Bul. No. 38, p. 36, Central Experimental Farm.

FEEDING TO HARDEN THE FAT OF PORK.

A rather anomalous state of affairs exists in the fact that while authorities in Canada counsel feeders to refrain from very extensive use of corn in pig feeding, farmers in the South generally feed corn to harden the pork, and the investigations of the experiment stations seem to bear out this practice. It is said that when pigs are grazed on such feeds as chufas, peanuts, or other oily feeds, the pork made is extremely soft and oily and the lard more or less liquid. To counteract this, corn is fed during the latter part of the feeding period or as a large part of the ration during the entire time the pigs are on feed. Recently the effect of cotton-seed meal on the fat has been investigated with good results so far as increased firmness is concerned.

Effect of corn.—According to Bennett,[a] if good grade or purebred pigs are grazed on peanuts or chufas, either alone or combined, and if at the same time they are fed an amount of corn sufficient to full feed exclusively for four weeks, the quality of the pork and lard produced can not be distinguished in appearance from that of pigs fed on corn exclusively. Bennett[a] regards the use of more than this amount of corn as too expensive for the results obtained. He also reports that his results have shown that purebred pigs or good grades produce a firmer quality of pork and lard than scrubs. The range of individual variation in the melting point of lard from scrubs was much larger than that of the lard from grades and purebreds. Duggar,[b] however, states that in his experience, even when fed a month exclusively on corn, pigs formerly on peanuts made much more oily and soft pork and lard than hogs fed corn throughout the entire feeding period. This condition was noticeable even after cooking. "One month of exclusive corn feeding increased the firmness of pork made from animals previously fed on peanuts alone, but the improvement was not sufficient to make the flesh or the lard as firm as the same articles afforded by animals fed entirely on corn." Both Bennett and Duggar state that while exclusive peanut feeding injures the sale of lard and pork by making it soft and oily the cooking quality does not seem to be impaired.

As parts of the grazing experiments already noted Bennett determined the effect of the feeds on the melting point of the lard. The following table shows the averages of his results for three years. Regarding the determination of the melting point Bennett[c] says: "The figures reported for each pig (back and kidney) are the averages of four determinations of each sample of lard previously rendered from samples of fat. The back fat was taken from one side of each pig, in a strip extending from a point over the kidneys to the thin edge of the side."

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[a] Bul. No. 65, Arkansas Expt. Sta.

[b] Bul. No. 93, Alabama Expt. Sta.

[c] Bul. No. 65, p. 103, Arkansas Expt. Sta.

Average melting point of lard from pigs on different feed.

Year.	Feed.	Number of pigs.	Average melting point.			
			Back.		Kidney.	
			°C.	°F.	°C.	°F.
1898	Grazed on peanuts, chufas, and soy beans without corn	7			37.0	98.6
	Grazed as above, followed by corn feeding ten days	4			34.2	93.6
	Fed corn exclusively	3			43.8	110.8
1899	Grazed on peanuts and chufas without corn to harden the lard	10	22.9	73.2	31.2	88.2
	Grazed as above, with corn to harden the lard	6	26.3	79.3	34.1	93.4
1900	Grazed on peanuts and chufas with corn	12	33.1	91.6	38.4	101.1
	Grazed as above, followed by corn feeding	8	32.5	90.5	37.8	100.0

Duggar[a] reports similar tests from the pigs in the Alabama experiments already mentioned. The melting points of lard from pigs fed in various ways were as follows:

Effect of corn on melting point of lard.

Ration.	Number of pigs.	Kind of lard.	Melting point of lard.	
			°F.	°C.
Corn	2	Leaf and body lard	111.2	44.0
Peanuts ½, corn ½	1	do	104.1	40.5
Peanuts	1	do	76.1	24.5

The following table shows the results of a test Duggar[b] conducted to determine the effects of feeding on corn alone after peanut feeding. The hogs had corn exclusively for one month before slaughtering:

Effect of corn on melting point of lard.

Ration previous to one month before butchering.	Melting point of lard.	
	°F.	°C.
Peanuts ½, corn ½	98.6	37.0
Peanuts	101.3	38.5

By comparing these figures with those immediately preceding, the effect of the corn feeding on the lot formerly on peanuts is apparent, but exclusive corn feeding had no appreciable effect on hogs that had formerly been on a ration consisting in part of corn. Bennett reached the same results at Arkansas. In his experiment of 1900

[a] Bul. No. 93, Alabama Expt. Sta.

[b] Idem.

there is very little difference in melting point between hogs fed corn while grazing peanuts and those having corn after grazing.

The effect of cowpeas and corn.—Duggar[a] has reported a number of additional experiments to study the hardening effect of various methods of feeding and different rations. Where a pig that was fed a ration of one-third ground cowpeas and two-thirds corn meal was compared with pigs which had grazed sorghum, peanuts, or chufas, with and without grain, the melting point of the fat of the jowl was determined as follows:

Effect of cowpeas and corn on the firmness of lard.

Feed during 26 days before butchering.	Feed prior to 26 days before butchering.	Melting point of fat.	
		° *C.*	° *F.*
Cowpea meal ⅓, corn meal ⅔; peanuts	Cowpea meal ⅓, corn ⅔; grazed sorghum.	28.0	82.4
Peanuts alone	Peanuts; grazed sorghum	22.0	71.6
Cowpea meal ⅓, corn meal ⅔; chufas	Grazed cowpeas	27.5	81.5
Cowpea meal ⅓, corn meal ⅔	Cowpea meal ⅓, corn ⅔	30.0	87.0

The softening effect of an exclusive peanut ration and the hardening effect of the ration of ground cowpeas and corn are manifest from the above table.

The effect of cotton-seed meal.—Pigs which had received the same previous treatment as the last three lots in the foregoing table were placed on a ration of cotton-seed meal one-fourth, corn meal three-fourths, for thirty-five days.[a] The melting point of the body fat was determined as follows:

Effect of cotton-seed meal on the firmness of lard.

Feed during 35 days before butchering.	Feed second month before butchering.	Melting point of fat.
		° *F.*
Cotton-seed meal ¼, corn meal ¾	Peanuts alone	87.4
Cotton-seed meal ¼, corn meal ¾	Cowpea meal ⅓, corn meal ⅔, chufas, etc	82.8
Cotton-seed meal ¼, corn meal ¾	Cowpea meal ⅓, corn meal ⅔[a]	84.9

[a] Full grain ration.

By comparing the above table with that which precedes it, it will be seen that where pigs had been grazing peanuts or chufas before being fed the cotton-seed-meal ration there was a marked effect on the firmness of the fat, but where they had been on a ration of cowpea meal one-third and corn meal two-thirds there was little or no effect.

[a] Bul. No. 122, Alabama Expt. Sta.

Another test[a] of a similar nature showed melting points of the body fat, as follows:

Effect of various feeds on the firmness of lard.

Number of pigs.[a]	Feed during 35 days before butchering.	Feed prior to 35 days before butchering.	Average melting point of body fat.
			° *F.*
2	Cotton-seed meal ¾, corn meal ¼	Peanuts	84.0
1	Corn meal	Peanuts	80.7
1	Corn meal (Essex pig)	Corn, grass pasture	86.0
2	Chufas	Peanuts	74.9
2	Peanuts	Peanuts	74.6

[a] Excepting the Essex pig, these were from the same litter.

These results show the softening effect of either peanuts or chufas and seem to give further evidence that a ration of cotton-seed meal and corn meal has an influence on the firmness of fat greater than that of a ration of corn alone. Duggar points out that these results do not show as firm fat as previous tests at the Alabama Station.

Another test gave still more evidence in favor of a cotton-seed meal ration, the results being as follows:[a]

Effect of cotton-seed meal on the firmness of lard.

Feed during 35 days before butchering.	Melting point of fat.	
	Kidneys.	Jowl.
	° *F.*	° *F.*
Cotton-seed meal ⅕, corn meal ⅘ (half ration); grazed sorghum	115.2	87.4
Cotton-seed meal ⅕, corn meal ⅘ (half ration); sorghum fed	115.2	85.3
Cotton-seed meal ⅕, corn meal ⅘ (half ration); grazed peanuts	99.7	80.6

The effect of cotton-seed meal, corn meal, and rice polish.—A test with these feeds following grain rations and feeding on pasture showed the following results:[a]

Effect of various feeds on the firmness of lard.

Number of pigs.	Feed during 31 days before butchering.	Feed from fifty-fifth to thirty-second day before butchering.	Average melting point of body fat.
			° *F.*
2	Cotton-seed meal ¼, corn meal ¾	Corn meal; peanuts	81.4
2	Corn meal	Corn meal; peanuts	78.0
1	Corn meal[b]	Grain ration	85.1
1	Corn meal; skim milk[c]	Corn meal; peanuts[d]	76.1
1	Rice polish[b]	Corn meal; peanuts[d]	74.2
1	Rice polish[b]	Grain ration	78.3

[a] Bul. No. 122. Alabama Expt. Sta.
[b] Fifty-six days.
[c] Milk for only nineteen days, and then in small amounts.
[d] Twenty-three days.

These results give still more evidence in favor of the use of a cotton-seed-meal ration to harden the fat. The body fat of the pigs fed in this manner was considerably firmer than that of those fed on corn meal.

Rice polish did not give so favorable results as corn meal.

Firmness of lard from immature pigs.—Young pigs, averaging about 60 pounds in weight at the middle of the experiment of thirty-seven days' feeding, were fed various rations and the melting point of the fat from the jowl and around the kidneys determined. The results were as follows:

Effect of immaturity on the firmness of lard.

Number of pigs.	Feed during 37 days before butchering.	Feed during preceding period of 42 days.	Average melting point of fat.	
			Kidneys.	Jowl.
			° *F.*	° *F.*
2[a]	Cotton-seed meal $\frac{1}{5}$, corn meal $\frac{4}{5}$	Grazed Spanish peanuts	86.7	67.4
2	Cowpea meal $\frac{1}{3}$, corn meal $\frac{2}{3}$	Grazed Spanish peanuts	80.7	72.3
2	Corn meal	Grazed Spanish peanuts	82.7	75.6
1[b]	Peanuts alone	Grazed Spanish peanuts	82.6	68.2

[a] One of the pigs in this lot died from the effects of cotton-seed-meal poisoning.
[b] This pig was butchered at the close of the forty-two days on peanuts.

These results agree with those of the Canadian experiments, that the fat of young and immature pigs is softer than that of mature ones. Duggar regards the low melting point of the fat of the pigs on cotton-seed meal in this test as due to accidental or unusual causes and therefore not of great value.

CHEMICAL COMPOSITION OF CARCASSES OF PIGS.

At the close of the Iowa experiment of 1897 one carcass from each lot, including the lots fed wide and narrow rations, was sent to Washington for analysis by the Division (now Bureau) of Chemistry[a] of the Department of Agriculture. The heads, leaf lard, and viscera were not included in the shipment, and no data are available on these parts. When the analyses were made no information was given as to the identity of the wide and narrow ration carcasses. Duroc Jersey No. 5 was from the lot fed the narrow ration, and No. 6 from those fed the wide ration.[b] In the discussion of the results these facts are considered, the tables being studied for the results with the several breeds, and then to compare the results of the two rations. The following table shows the proportions of the various parts of the carcasses:

[a] Bul. No. 53, Div. Chemistry, U. S. D. A.
[b] Bul. No. 48, p. 408, Iowa Expt. Sta.

Relative proportions of the dressed animal, the head, leaf lard, and kidneys having been removed.

Serial number and breed of pig.	Weight (Washington).	Percentages of parts.							
		Meat (fat and lean).	Bones, less marrow.	Marrow.	Skin.	Spinal cord.	Tendons.	Hoofs.	Total.
	Pounds.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1. Berkshire	129.6	88.19	7.44	0.12	3.80	0.09	0.27	0.09	100
2. Tamworth	141.0	86.50	8.18	.21	4.71	.09	.21	.10	100
3. Chester White	125.8	87.94	6.21	.08	5.52	.07	.12	.06	100
4 Poland China	146.4	90.67	5.30	.11	3.63	.08	.14	.07	100
5. Duroc Jersey (narrow ration)	137.6	88.03	5.92	.11	5.75	.04	.10	.05	100
6. Duroc Jersey (wide ration)	167.1	90.93	4.70	.10	4.00	.07	.12	.08	100
7. Duroc Jersey	149.2	89.90	5.07	.11	4.65	.08	.11	.08	100
8. Yorkshire	160.3	86.79	7.41	.13	5.30	.09	.18	.10	100
Means	144.6	88.62	6.28	.12	4.67	.08	.16	.08	100
Maxima	167.1	90.93	8.18	.21	5.75	.09	.27	.10	100
Minima	125.8	86.50	4.70	.08	3.63	.04	.10	.05	100

Considering the carcasses that were in the breed test proper, the Yorkshire carcass is found to be very much the heaviest and the Chester White the lightest.

In relative weight of meat there is not a great amount of variation, the Poland China having the greatest weight, 90.67 per cent, and the Tamworth the least, 86.50 per cent. In relative weight of bones, less marrow, there is a range from 5.07 per cent in the Duroc Jersey to 8.18 in the Tamworth. The marrow varies from 0.08 per cent in the Chester White to 0.21 per cent in the Tamworth carcass. The skin shows a minimum of 3.63 per cent in the Poland China and a maximum of 5.52 per cent in the Chester White carcass. The weight of the spinal cord is 0.09 per cent in the Berkshire, Tamworth, and Yorkshire, and 0.07 in the Chester White. In weight of tendons, the Berkshire shows the highest percentage, 0.27, the Duroc Jersey the lowest, 0.1 per cent. In hoofs, the Tamworth and Yorkshire carcasses together were heaviest, with 0.1 per cent of the live weight, and the Chester White least, with 0.06 per cent.

It is difficult to notice any effect that may have been due to the feed which Duroc Jersey No. 5 (narrow ration) and Duroc Jersey No. 6 (wide ration) received. It will be recalled that the nutritive ratio of the narrow ration was 1:4.1, and that of the wide ration 1:7.8. There is a difference in favor of the wide-ration lot of nearly 3 per cent in weight of meat, of 1.22 per cent in weight of bones, and of 1.75 per cent in weight of skins in favor of the narrow ration. The weight of marrow is 0.11 per cent of the dressed weight in the nar-

row-ration carcass and 0.1 per cent in the wide ration. The weight of spinal cord is 0.04 per cent and 0.07 per cent of the narrow and wide rations, respectively, this amount for the narrow ration being the least in the table. The percentages of tendons are 0.1 and 0.12, respectively, for the narrow and wide rations, and of hoofs 0.05 per cent and 0.08 per cent, respectively. In a number of particulars the maxima or minima of the table were found for one of these carcasses, which will explain seeming inaccuracies in the preceding paragraph.

The following table shows analytical data for the carcasses examined:

Analytical data of the dressed animal, the head, leaf lard, and kidneys having been removed.

Serial number and breed of pig.	Weight.	Water.	Fat.	Nitrogenous substances.				Lecithin.	Ash.	Total.
				Proteids insoluble in hot water.	Gelatinoids.	Flesh bases.	Total.			
	Pounds.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
1. Berkshire	$129\frac{3}{5}$	43.10	40.46	10.45	0.89	1.16	13.02	0.27	2.57	99.42
2. Tamworth	141	41.09	42.97	9.65	1.15	1.14	11.99	.17	2.63	98.85
3. Chester White	$125\frac{4}{5}$	35.80	51.11	7.39	.92	1.50	9.85	.17	1.84	98.77
4. Poland China	$146\frac{2}{5}$	37.83	48.90	7.27	1.11	1.21	9.66	.19	1.83	98.41
5. Duroc Jersey (narrow ration)	$137\frac{3}{5}$	32.32	55.07	6.55	1.24	1.14	8.99	.11	2.01	98.50
6. Duroc Jersey (wide ration)	$167\frac{1}{10}$	30.31	56.81	7.73	.93	1.11	9.80	.19	1.75	98.86
7. Duroc Jersey	$149\frac{1}{5}$	30.58	57.68	7.03	1.10	.78	8.96	.42	1.81	99.45
8. Yorkshire	$160\frac{3}{10}$	40.39	44.35	8.89	1.42	1.08	11.44	.31	2.40	98.89
Means	$144\frac{5}{8}$	36.43	49.67	8.12	1.10	1.14	10.46	.23	2.11	98.90
Maxima	$167\frac{1}{10}$	43.10	57.68	10.45	1.42	1.50	13.02	.42	2.63	99.45
Minima	$125\frac{4}{5}$	30.31	40.46	6.55	.89	.78	8.96	.11	1.75	98.41

In this table the nitrogenous substances "are divided into three classes, namely, the true proteids insoluble in hot water; gelatinoids, which are of a true proteid character, but soluble in hot water, and of which gelatin is the type; and the flesh bases which are soluble in hot water and are not precipitated by the action of bromin."[a]

Lecithin was determined by extraction with a mixture of alcohol and ether and the determination of the phosphorus in the extract. As some of the lecithin is removed when the fat is extracted with ether, the determination of lecithin in the fleshy residue of the meat after fat extraction did not represent all the lecithin which was in the meat. On the other hand, in the case of marrow and spinal cord, a great proportion of these substances is fat, and for this reason and the additional one that there was a very small amount of material available for analysis, the lecithin in the fat extracted was deter-

[a] Bul. No. 53, p. 66, Div. Chem., U. S. D. A.

mined as the amount in the original sample. For these reasons it is pointed out that the figures for lecithin represent less rather than more of the actual amounts in the original samples. Wiley, under whose direction the analyses were made, regards lecithin as very important physiologically.

In studying this table it is useless to attempt any differentiation to show the influence of the rations fed, for it is at once apparent that in the case of the narrow ration carcass (Duroc Jersey No. 5), the breed influence predominated, because, in spite of the fact that this carcass was fattened by the use of a nitrogenous ration, it will be seen that the analyses agree closely with those of the Duroc carcass in the breed test and the one on the wide ration.[a]

It is seen that the amounts of water and fat in these analyses bear an almost constant relation to each other—a minimum quantity of fat being found with a maximum quantity of water. For example, the greatest amount of water is shown in the Berkshire carcass, which also has the least amount of fat. The Duroc Jersey carcasses show a slight variation, in that carcass No. 6 (wide ration) is least in water content, with 30.31 per cent, but seventh in fat content, with 56.81 per cent. The greatest amount of fat was found in the carcass from the breed test No. 7, with 57.68 per cent. It is significant that the three Duroc Jersey carcasses are least in water content and greatest in fat content. The proportion of total nitrogen shows a tendency to vary with the amount of fat present, and does so in the case of the Berkshire, Tamworth, and Yorkshire carcasses. In proteids insoluble in hot water the Berkshire, Tamworth, and Yorkshire carcasses lead in the order named, which is the only feature of note in this column. If we consider the results for proteids insoluble in hot water, there does not seem to be any variation in gelatinoids and flesh bases that may be ascribed to breed influence; in fact, with a few exceptions, there is little variation from the mean.

The greatest percentage of lecithin (0.42) is seen in the Duroc carcass No. 7, and the least (0.11) in Duroc No. 5 (narrow ration).

The wide-ration Duroc shows .19 per cent lecithin—somewhat below the mean; the Tamworth, Berkshire, and Yorkshire, which had the greatest weight of bones, stand in the same relative order in ash content. The same tendency appears with the other carcasses, Duroc No. 7 (breed test) and Duroc No. 6 (wide ration) being seventh and eighth both in weight of bones and ash content.

Water content of fat of pigs fed various rations.—At the close of the Wisconsin experiment which compared a ration of pea meal, middlings, and skim milk with one of corn meal and skim milk, the fat

[a] The reader should recall, however, that the narrow ration was not very different in nutritive ratio from the one used in the breed test, the one being 1:4.1; the other, 1:5.6.

of the kidney and loin of 2 pigs in each lot was analyzed to determine the water content, with the following results:

Water content of fat of pigs. (Woll.)[a]

Feed and breed.	Kidney fat.	Loin fat.
	Per cent.	*Per cent.*
Corn meal and skim milk:		
Poland China	2.6	3.82
Yorkshire	3.15	4.55
Average	2.87	4.18
Ground pease, middlings, and skim milk:		
Poland China	8.27	7.02
Yorkshire	3.71	5.88
Average	5.99	6.45

[a] Seventeenth An. Rpt., Wisconsin Expt. Sta.

The fat from pigs on the narrow ration contained considerably less water than that from the pigs on the wide one. Carlyle and Hopkins[a] remark that they are not prepared to state what effect the larger percentage of water in the fat from the narrow-ration pigs would have "on the curing and edible qualities of the meat," but the smaller amount of water in the kidney fat of the corn-fed pigs would certainly add to its value "over the other for lard-rendering purposes."

SUCKLING PIGS ON A SKIM-MILK DIET.

Experiments with suckling pigs on a diet of separated cow's milk alone and milk to which lactose or dextrose had been added, have recently been reported by Miss Margaret B. Wilson.[b] Preliminary to the report on her work, she presents the results of similar studies by Sanford and Lusk at the Yale Medical School. In these latter experiments 1 pig was fed a ration of skim milk plus 2 per cent of milk sugar (lactose), a second a ration of skim milk plus 3 per cent dextrose, and the third skim milk only. A new-born pig from the same litter was killed and analyzed in order to determine the growth in proteid substances, the amount in the new-born pig being taken as that of the others, and the difference between the estimated amount at birth and the amount found by analysis at the close of the feeding was attributed to growth. The pigs were fed fourteen days.

Miss Wilson conducted her studies along similar lines, and throughout compared her results with those obtained by Camerer, Rubner, Oppenheimer, and others in studying the nutrition of growing infants.

Six new-born pigs from the same litter were obtained. Three of them were at once submitted to analysis, and 3 were reared on skim milk. Of these 3 the skim-

[a] Seventeenth An. Rpt., p. 22, Wisconsin Expt. Sta.
[b] Amer. Jour. Physiology, VIII, 3.

milk pig was fed on skim milk alone; the lactose pig received the same skim milk to which 3 per cent of lactose had been added; and the third pig, the dextrose pig, was nourished with the same skim milk containing 3 per cent of added dextrose. After sixteen days the pigs were killed and submitted to analysis.

The following table is presented to show some of the results relating to growth in both series of experiments:

Growth of suckling pigs.

	Wilson.			Sanford and Lusk.		
	Skim milk.	Lactose.	Dextrose.	Skim milk.	Lactose.	Dextrose.
Weight when born ....grams..	1,322.0	1,295.0	1,485.0	1,000.0	1,050.0	1,152.0
Weight when killed ....do...	2,205.0	2,435.0	2,471.0	1,246.0	1,890.0	2,000.0
Growth ....do...	883.0	1,140.0	986.0	264.0	838.0	848.0
Growth ....per cent..	66.8	88.0	66.4	26.4	79.7	73.6
Milk fed ....c. c..	10,925.0	11,005.0	9,707.0	6,826.0	8,836.0	9,481.0
Available calories fed..............	4,053.0	5,216.0	4,620.0	2,339.0	3,736.0	3,972.0
Growth per liter of milk..grams..	81.0	114.0	101.0	38.0	95.0	89.0
Growth per 1,000 calories fed .do...	218.0	215.0	213.0	114.0	222.0	213.0

Miss Wilson calls attention to the fact that, with the exception of the skim-milk pig in Sanford and Lusk's experiment, which was a poorly nourished pig that did not do well at any time, the growth of all these pigs was "directly proportioned to the calorific value of the food to the organism." She notes that Oppenheimer has obtained similar results with normal breast-fed children of the same age.

Further details relating to the growth of the pigs were ascertained. The analyses of the 3 new-born pigs were as follows:

	Grams.	Per cent.
Live weight (aggregate)........	3,247.0	....
Dry solids........	637.4	19.7
Fat........	47.56	1.15
Proteid........	390.5	12.0
CaO (average of 2 pigs)........	....	1.88

From these results data regarding the growth of the other pigs were obtained as follows:

Growth of suckling pigs. (Wilson.)

Ration.	Estimated composition at beginning.				Growth.			
	Solids.	Fat.	Proteid.	CaO.	Solids.	Fat.	Proteid.	CaO.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*
Skim milk.........	260.4	15.20	158.90	24.85	175.8	13.18	162.4	11.32
Lactose..........	255.1	14.89	155.66	24.35	240.5	20.01	204.3	15.42
Dextrose..........	292.5	17.08	178.50	27.92	202.7	16.16	170.6	12.35

From these figures, and those relating to the feed eaten, Miss Wilson compiled the following table to show the relation between the amount of growth and consumption of feed:

Relation between feed consumed and growth.

Ration.	Feed.			Growth.			Feed used for growth.		
	Proteid.	Fat.	CaO.	Proteid.	Fat.	CaO.	Proteid.	Fat.	CaO.
	Grams.	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Grams.*	*Per ct.*	*Per ct.*	*Per ct.*
Skim milk	455.6	15.29	21.74	162.4	13.18	11.32	35.6	86	52
Lactose	458.9	15.40	21.90	204.3	20.01	15.42	44.5	130	70
Dextrose	404.8	13.59	19.32	170.6	16.16	12.35	42.1	111	64

In Sanford and Lusk's experiments, reported by Miss Wilson,[a] the amount of proteid substances used to build up new tissue was 23 per cent for the pig on skim milk only, 38 per cent for the one on lactose, and 48 per cent for the one on dextrose. According to Miss Wilson, W. Camerer, jr.,[b] found 40 per cent proteid of the food retained for growth by a nine-weeks-old nursing infant. The results in the table show 35.6 per cent proteid retained for growth by the pig on skim milk, 44.5 per cent by the pig on lactose, and 42.1 per cent by the pig on dextrose. These results agree closely with the work quoted, especially when it is remembered that the skim-milk pig in Sanford and Lusk's experiment was not thrifty.

The relative amount of fat of growth compared to that in the food is 86 per cent with the skim-milk pig, 130 per cent with the lactose pig, and 111 per cent with the dextrose pig. This large increase is attributed to two factors—a possible error in the estimation of fat in the food and the conversion of milk sugar into fat. As the fat was "almost completely assimilated," these results show "that the carbohydrates fed were amply sufficient to furnish the needed energy, while a normal growth of tissue was progressing. No fat combustion was necesary for the life processes."

The calcium used for growth was 52 per cent of that in the food consumed by the skim-milk pig, 70 per cent of that consumed by the lactose pig, and 64 per cent of that consumed by the dextrose pig. As the dry solids of the 3 pigs contained, respectively, 8.29, 8.02, and 8.13 per cent of calcium, it is held that "the calcium addition depended rather upon the development of the organism than upon any specific influence of the milk constituents." Miss Wilson's results show an average of 9.40 per cent of calcium in the new-born pig and an average of 8.15 per cent at the age of sixteen days.

The energy stored in the animals during growth was estimated to be 772 calories in the skim-milk pig, of which 16 per cent was in the fat deposited; 1,002 calories in the lactose pig, of which 18.6 per cent

[a] Amer. Jour. Physiology, VIII, 3, p. 200.

[b] Loc. cit., p. 207.

was in the fat; and 832 calories in the dextrose pig, of which 18 per cent was in the fat. The following table shows facts relating to energy:

Energy liberated in growing pigs. (*Wilson.*)

Energy—	Skimmed milk.	Lactose.	Dextose.
	Calories.	*Calories.*	*Calories.*
In the food	4,053	5,216	4,620
Stored in the body	772	1,002	832
Liberated as heat	3,281	4,214	3,788
Fed daily per square meter of surface	2,008	2,404	2,087
Liberated as heat daily per square meter of surface	1,618	2,005	1,600
Retained per 1,000 calories in the feed	191	192	180

According to Miss Wilson, "the human infant requires daily in the food about 1,200 calories per square meter of surface, while a more active older child requires 1,500." All of the pigs required over 2,000 calories per square meter of surface, and that of the lactose pig 2,400; this "corresponds to that needed by a man at hard labor." The large requirement is explained by the active, bustling life of the young pigs, which was "to a very large degree a life of hard work." Attention is called to the fact that not only did the pigs gain in weight in proportion to the number of calories in the food, but the energy stored in the body was also in proportion to the number of calories in the food.

Miss Wilson concludes that "a large and apparently normal growth" may be attained by the use of skim milk, and that the addition of sugars has a good effect, adding calorific power to the milk. She regards it as unessential whether fuel value is added to skim milk by fat, milk sugar, or dextrose, provided there is a sufficient amount of proteid in the milk; sucklings will grow well under any of these circumstances. This conclusion emphasizes the importance of the experiments by Wilson and Curtiss[a] at the Iowa Experiment Station, who found that corn meal could supply the place of fat in skim milk when fed to calves. The summary of these experiments is inserted entire as follows:

(1) Skimmed cow's milk, with or without 2 to 3 per cent of added lactose or dextrose, is normally absorbed by suckling pigs.

(2) Two pigs fed on skim milk from fourteen to sixteen days gained 26.4 and 66.8 per cent in weight. Two pigs fed on skim milk, with 2 and 3 per cent of lactose added, gained 79.7 and 88 per cent in weight. Two pigs fed on skim milk, with 2 and 3 per cent of dextrose added, gained 73.6 and 64.4 per cent in weight.

(3) Those fed with plain skim milk gained 114 and 218 grams in weight for every 1,000 physiologically available calories in the food. The lactose pigs gained 222 and 215 grams per 1,000 calories in the food. The dextrose pigs both gained 213 grams per 1,000 calories in the food. Except in the case of one ill-nourished skim-milk pig the growths of the sucklings stand in a constant ratio to the calories in the food.

[a] Buls. Nos. 19, 25, and 35. The calves fed were considerably older than the pigs in the experiments at New Haven.

(4) The pigs fed on plain skim milk used 23 and 35 per cent of the proteid in the food for tissue growth, the lactose pigs used 38 and 44 per cent, and the dextrose pigs 48 and 42 per cent.

(5) All the pigs of the second litter gained in fat when fed on plain skim milk or on skim milk with sugars.

(6) The percentage of calcium in the bodies of the pigs diminished with their growth. There was considerable and normal deposition of calcium in the pig, and this was proportional, not to the calcium in the food, but to the growth of the animal.

(7) Not only is the growth in grams of the pigs proportional to the calories in the food, but the number of calories retained in the tissue substance during growth is proportional to the calories in the food. From 18 to 19 per cent of the calories in the food were found stored in the tissue growth of the pigs fed on the three varieties of skim milk.

(8) There seems to be striking evidence that the suckling pig reared on skim cow's milk conforms to the same laws of nutrition as the breast-fed infant.

MISCELLANEOUS EXPERIMENTS AND INFORMATION.

ACORNS.

Carver[a] has shown that acorns compare rather favorably with corn in chemical constituents. Hogs fattened on them yield rather soft, spongy flesh, with an oily lard that hardens with difficulty. This, it is suggested, might be overcome by feeding corn a few weeks before marketing. Districts in Alabama are mentioned where cattle and hogs live entirely on acorns and the pipe-stem cane.

EXPERIMENTAL PORK ON THE ENGLISH MARKET.

After each slaughtering of the Iowa pigs (see pp. 179–180) a Chicago firm shipped some of the pork to their agents at Liverpool, for sale on the English market. Very complete reports were received regarding the suitability of these cuts abroad.

In 1897 the opinion of the packers, before the above shipment was made, was that the Berkshire and Tamworth pigs were "the most suitable for the making of English meats."[b] The lots of pork that were unsuitable on account of feeding were one of long cut hams from Poland China pigs and one of long-cut hams from Chester White pigs which were "too fat and short." One lot of American-cut hams from the Berkshires was rendered unsuitable for the English market by cutting. Some of the cuts were criticised as soft and spongy, others as somewhat fat, but they were not necessarily condemned on account of fat. A tendency in the Yorkshire long-cut hams to be "rather stout" was remarked upon.

In 1898 a still more complete report was received concerning the cuts that were shipped to England. The cuts from the Tamworths

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[a] Bul. No. 1, Alabama, Tuskegee Inst. [b] Bul. No. 48, p. 391, Iowa Expt. Sta.

were all reported suitable for the English trade, although some were criticised as being somewhat too fat. The Berkshire cuts were given second place, only two being condemned as being too fat for the British market. The showing of the Yorkshire cuts in this shipment was surprising. Out of eight Cumberlands cut from Yorkshire pigs only one was suitable for export, the others being "much too fat." Out of eight Yorkshire short-cut hams four were condemned on account of fat. The Yorkshire cuts were the least suitable of the shipment.

This characteristic of the Yorkshires in this experiment brings up the very important question regarding the influence of feed on the carcass. It also shows how individual and family characteristics are strong factors in experimental work. In justice to the breed it should be said that it is highly valued for its high-class pork products and is employed in every country where the production of prime bacon is a feature of pig feeding. The breed is more extensively used than any other in Denmark, where the finest bacon of international trade is produced. Yet in the Iowa tests it was said that the Yorkshires were deficient, "as the thickness of fat on the back was much greater than the trade desired."[a] The suitability of the Yorkshires for the export bacon trade is shown in the résumé on the Ontario Agricultural College work in the following paragraph:

Summarizing the results of five years of work with six breeds at Guelph, Day would rank the Yorkshire first in suitability for the export trade, placing the Tamworth second and the Berkshire third. The showing of the other breeds that were fed (Chester-White, Duroc Jersey, and Poland China) was so unsatisfactory in the production of export bacon that they could not be graded.[b] The opinion of the packer in one of the earlier tests has already been mentioned. (See pp. 207–208.) In a breed test inaugurated in collaboration with the Dominion department of agriculture the Yorkshires and Berkshires were the only breeds that made a satisfactory showing. "There were practically no culls among these breeds."[c]

THE EFFECT OF HOG RAISING ON THE FERTILITY OF THE LAND.

Following the grazing experiments, in 1898, with pigs on peanuts, chufas, and soy beans, Bennett[d] noted the effect which the grazing of the pigs and the growth of the various crops had on the soil and the cotton yield per acre. The effect was noted during the year immediately following the grazing and also for the second year. planting to ground on which corn had been grown the year before A plat of cotton was used as a check. The results, showing the

[a] Bul. No. 48, p. 429, Iowa Expt. Sta.
[b] An. Rpt., 1900, p. 48, Ontario Agricultural College.
[c] Rpt., 1901, p. 62, Ontario Agricultural College.
[d] Bul. No. 68, Arkansas Expt. Sta.

amount of seed cotton produced per acre, were as follows for the first year:

	Pounds.
Cotton following peanuts grazed by pigs	1,771
Cotton following chufas grazed by pigs	1,200
Cotton following soy beans grazed by pigs	1,588
Cotton following corn cut and stover removed	1,005

The effect of the grazing was similarly shown in the cotton yield during the second year, although the yields are said to have been decreased by unfavorable climatic conditions. The following statement shows the amount of seed cotton produced per acre the second year after grazing:

	Pounds.
Second crop cotton following peanuts	1,134
Second crop cotton following chufas	981
Second crop cotton following soy beans	1,020
Second crop cotton following corn	798

These figures show that during the first year after grazing on peanuts, soy beans, and chufas the manure left by the pigs, supplemented by the fertilizing properties of the plants themselves, increased the yield of seed cotton from nearly 20 to more than 76 per cent per acre over the yield from a plat where corn had been grown; and that during the second year the yield in favor of the grazed plats was still apparent, ranging from over 22 per cent to over 42 per cent more on the grazed than on the ungrazed plats. Naturally some of the increased yield must be attributed to the fertilizing value of the peanuts and soy beans, but as chufas are not leguminous plants and, therefore, are not equipped with nitrogen-gathering bacteria, the figures where they were used show quite accurately the manurial effect of the grazing. The increased yield on the chufa-grazed plats was nearly 20 per cent the first year after grazing and over 22 per cent the second year after.

In reporting the Tennessee experiments Soule and Fain estimated the value of the manure made by the pigs. The method of calculation used in the experiment of 1901 is not explained. In the experiments of 1902–3 the available manure was estimated at 75 per cent of the excrement voided by the animals, and its value was calculated by estimating nitrogen at 15 cents per pound, potash at 5 cents, and phosphoric acid at 5 cents. The following shows the value of the manure made during the experiment of 1901:

Value of manure in pig feeding.

Ration.	Number of pigs.	Number of days fed.	Value of manure.
Corn meal	3	60	$2.06
Corn meal and skim milk	3	60	4.12
Corn meal, wheat meal, and dairy by-products	3	60	3.80
Corn meal, cowpea hay, and skim milk	2	60	2.15

The following shows the estimated value of the manure made during the experiments of 1902–3. There were 3 pigs in each lot in the tests of 1902 and 4 in each lot in 1903. They were fed sixty days in 1902 and seventy-seven days in 1903:

Value of manure in pig feeding.

Ration.	Value of manure.
Wheat meal, corn meal, and skim milk	$3.43
Wheat meal, corn meal, and skim milk	4.34
Wheat meal, corn meal, and skim milk	5.00
Wheat meal, corn meal, and skim milk	5.23
Wheat meal, corn meal, and skim milk	4.18
Soy-bean meal, corn meal, and skim milk	4.91
Corn meal and skim milk	4.04
Corn meal	1.20

The high fertilizing value of rations composed to a considerable extent of nitrogenous feeds, such as the skim-milk rations and the soy-bean-meal ration, is apparent.

The value of the manure as a by-product of animal husbandry can not be too strongly emphasized, especially in those sections of the country, like the South, where the fertility of the land has, to a certain extent, been lost. The South supports the greater part of the business of the country in commercial fertilizers, and, while paying enormous sums annually in this manner, can not look forward to anything but greater impoverishment of the soil unless the production of live stock is increased and the manure carefully utilized.

INFLUENCE OF PROTEIN AND MINERAL MATTER ON ECONOMY OF GAIN.

The Kansas Station[a] studied the relative effects of rations, rich and poor, in protein and mineral matter in their effects on the cost of gain, with the following results:

Value of protein and mineral matter in feeding pigs.

Ration.	Protein.	Mineral matter.	Feed for 100 pounds gain.
	Pounds.	*Pounds.*	*Pounds.*
Corn 66⅔ pounds, soy beans 33⅓ pounds	15.1	2.6	369
Kafir corn 66⅔ pounds, soy beans 33⅓ pounds	14.8	3.3	374
Kafir corn 80 pounds, soy beans 20 pounds	11.8	2.9	408 to 468
Corn 100 pounds	7.8	1.5	457 to 479
Kafir corn 100 pounds	7.3	2.5	471 to 749

This station calls attention to the need of mineral matter in a pig's ration, which is not supplied by Indian or Kafir corn. In experiments where pigs were confined in a stone piggery and fed either of these grains exclusively they craved mineral matter to such an extent "that they ate the mortar from between the stones."

To supply the needed protein where corn or Kafir corn forms the

[a] Bul. No. 95.

basis of fattening, soy beans are recommended, as they are regarded as the richest feed in protein raised on Kansas farms.

BONE MEAL IN A CORN-MEAL RATION.

It is generally understood that a strictly corn or corn-meal diet does not supply a sufficient amount of bone-making material (potash and phosphoric acid) to supply the wants of the animal body, and this is one reason that corn is so strongly condemned for young and growing animals. At the Cornell Station[a] Clinton fed bone meal in small amounts to pigs on corn and milk, and to others a mixture of corn meal and middlings and milk. The amount in the first trial was 1 ounce of bone meal to each 500 pounds of live weight daily; that in the second was not stated. In the first test "it did not produce any apparent results upon the health of the animals or upon the economy in the use of foods;" in the second "the bone meal seems to have produced beneficial results when fed in conjunction with the corn-meal ration, but not when fed with the grain mixture." Skim milk doubtless minimized considerably the possible effects of the bone meal.

RESULTS AT DIFFERENT PERIODS OF GROWTH.

Relative production of pork before and after weaning.—At the Al. bama Station Duggar[b] fed a sow and her litter of 7 pigs from the time of farrowing, February 24, to April 1, 1899, in a bare lot on a mixture of equal parts by weight of ground cowpeas and very coarse rice meal, consisting largely of rice chaff. The sow and pigs ate 273 pounds of the meal, the sow losing 29.6 pounds in this time and the pigs gaining 67.3 pounds, making a net gain of pork produced of 37.7 pounds, an average daily gain for the pigs during the thirty-five days of 0.15 pound.

On April 1 the sow and litter were placed in hurdles on a field of hairy vetches and turf oats, which were sown the previous October on poor upland soil. The sow was removed after five weeks, but the pigs continued for three weeks longer, making a net average daily gain of 0.13 pound.

The following table shows the results of this experiment:

Feed ng pigs before and after weaning.

	Before weaning.	After weaning.
Number of pigs	7	7
Weight of pigs at beginning ... Pounds..	118.60	232.20
Gain of pigs ... do....	113.60	55.40
Loss of sow ... do....	19.40	----------
Net gain of sow and pigs ... do....	94.20	----------
Average daily gain of pigs ... do....	.46	.38
Average net daily gain of sow and pigs ... do....	.34	----------
Meal consumed by sow and pigs ... do....	554.20	[c] 244.00
Meal per pound gain of pigs ... do....	488.00	440.00
Meal per 100 pounds net gain of sow and pigs ... do....	588.00	----------
Total weight of sow and pigs at beginning ... do....	350.30	----------

[a] Bul. No. 199. [b] Bul. No. 122. [c] Only pigs during last three weeks.

These results show that the losses in weight of the sows, due to the drain of milking, make the production of pork while the pigs are on the dams a somewhat expensive business. Sows differ considerably in their ability to give large milk yields without consequent losses in weight. There have been cases where very good gains were made by the sow while suckling a litter (see p. 179). Duggar[a] is of the opinion that it is quite possible to maintain weight while suckling, provided the sow is given a nutritious ration. In an experiment where he fed a sow and her litter of 9 pigs on Spanish peanuts, corn meal, and skim milk the sow gained 9 pounds in weight in thirty-five days and the pigs 227 pounds, a total gain of 236 pounds. The cost of the grain and skim milk per 100 pounds gain was $2.50. Duggar regards this test as evidence "that on a sufficiently nutritious and palatable diet the weight of the nursing sow can be maintained."

Gains of pigs at various weights.—Linfield[b] averaged his results of experiments to show the gains of hogs at various weights. The table showing these averages is as follows:

Gains of pigs at various weights.

Weight.	Ration.	Number of tests.	Number of pigs.	Average daily gain.	Dry matter eaten daily.	Digestible matter eaten daily.	Feed per 100 pounds gain.		Dry matter per 100 pounds gain.	Digestible matter to 100 pounds gain.	Grain equal to 100 pounds skim milk.
							Grain.	Milk.			
				Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
From 44 to 102 pounds live weight.	Milk and grain	9	31	1.12	2.79	2.25	194	829	250	203	28.4
	Grain	6	16	.80	3.03	2.30	430		385	292	
	Milk	4	11	.75	1.88	1.79		2,838	257	244	15.1
From 102 to 152 pounds live weight.	Milk and grain	10	34	1.42	4.93	3.93	297	879	348	277	13.6
	Grain	4	12	1.18	4.40	3.34	417		373	283	
From 152 to 199 pounds live weight.	Milk and grain	8	27	1.51	5.74	4.52	357	717	381	304	28.7
	Grain	2	6	1.12	5.65	4.32	563		501	383	
From 200 to 255 pounds live weight.	Milk and grain	5	19	1.39	5.79	4.51	409	590	422	329	27.8
	Grain	1	2	.97	5.83	4.44	673		599	457	

These results generally corroborate the views of previous authorities on the subject of the influence of increasing age on the rate and economy of gain. A noticeable fact is that, except for the grain-fed lots, the economy of gain was greatest in the youngest pigs, decreasing as the pigs became older. With the grain-fed pigs the cheapest gains were made from 102 to 152 pounds, but after this weight the increase in cost of gain was rapid. The rate of gain is not so uniform, but the figures show pretty clearly that the greatest gains were made from 102 to 152 pounds, although those pigs on milk and grain made the largest gains from 152 to 199 pounds.

[a] Bul. No. 122, Alabama Expt. Sta. [b] Bul. No. 57, Utah Expt. Sta.

WATER DRUNK AT VARIOUS WEIGHTS.

From data reported by the Indiana Station[a] to study the effect of water in the feed, the writer has compiled a table showing the amount of water consumed during the experiment. The following table shows some of the leading features of this experiment:

Daily consumption of water at approximate weights.

Lot.	Ration.	Number of pigs.	Daily consumption of water by pigs weighing—								
			60 lbs.	70 lbs.	80 lbs.	90 lbs.	105 lbs.	125 lbs.	156 lbs.	180 lbs.	215 lbs.
			Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Lot I	Grain (dry)	4	2.35	3.00	2.42	4.21	4.82	7.50	11.42	9.44	11.07
Lot II	Grain and water (1:1).	4	2.42	3.27	3.35	3.27	4.50	5.60	7.50	8.39	8.17
Lot III	Grain and water (1:2).	4	4.25	6.C3	6.00	6.00	7.00	9.00	11.00	14.00	14.00
Lot IV	Grain and water (1:3).	4	5.79	8.25	9.00	9.00	10.50	13.50	16.50	18.00	18.00

These figures show little difference in the consumption of water when feed was given dry and when mixed with an equal weight of water. The increase of the consumption of water with age is gradual, but not regular. The pigs that were forced to drink large quantities of water to get enough feed to satisfy hunger evidently drank more than they needed, if the figures of the dry-grain lot are a criterion.

GAIN OF PIGS FOLLOWING CATTLE.

Morrow and Bone,[b] in Oklahoma, report a case where 5 pigs following steers that were full fed on corn and Kafir meal "gained only 195 pounds, or 39 pounds each, in fifty-six days. In another case 5 pigs gained 100 pounds in fifty-six days; and in a third 6 moderate-sized sows gained 245 pounds in fifty-six days."

BARROWS COMPARED WITH SOWS.

Foster and Merrill, in Utah,[c] made two tests to compare the relative fattening values of barrows and sows. In the first test of ninety-one days, 6 barrows made an average daily gain of 0.9 pound, and 3 sows an average daily gain of 0.83 pound; in the second test of one hundred and thirty-three days, 3 barrows made an average daily gain of 0.7 pound, and 6 sows an average daily gain of 0.88 pound.

SPAYED COMPARED WITH UNSPAYED SOWS.

The same station fed 6 half-blood Berkshire sows, 3 of which were spayed and 3 were not, on a varied diet for one hundred and sixteen days.[c] The spayed sows made a daily average gain of 0.82 pound, and the unspayed sows an average daily gain of 0.86 pound. No difference of appetite was noticed.

[a] Bul. No. 86.
[b] An. Rpt., 1898-99, Oklahoma Expt. Sta.
[c] Bul. No. 70, Utah Expt. Sta.

BUTCHERS' TERMS.

Very frequently experiment station literature on animal husbandry contains reference and tables relating to slaughter tests in packing houses. The following definitions of the terms applied to the offal and the uses of these parts have been supplied by Dr. U. G. Houck, Inspector, Bureau of Animal Industry, National Stock Yards, Ill. In this connection, the reader may find it interesting to refer to the definitions on page 186:

Melt (spleen): Uses: Tanked in offal tank.

Head, gross: Weight of head before any portion has been trimmed away.

Head, net: Head after tongue, jowls (cheeks), snout, and ears have been trimmed away.

Tongue: Uses: Boiled and pickled.

Cheek meat: Masseter muscles (*masseter externus* and *ptyerygoideus internus*). Uses: Sausage.

Cheek-meat fat: Small pieces of the fatty portion of the jowls that are unintentionally left attached to the masseter muscles when the jowls are trimmed away. Uses: Rendered into lard.

Leaf lard: A thick layer of fat extending anteroposteriorly and attached to the sublumbar and lateral abdominal parietes. Uses: Lard.

Kidneys: Uses: Human food; also one of the ingredients in the manufacture of chicken and dog feeds.

Gullet: Includes larynx, short pieces (3–6 in.) each of the trachea and esophagus and the fat attached to the parts. Uses: Fat trimmed away for lard and the remaining parts tanked in the grease tank.

Gullet fat: Fat at base of tongue that remains attached to the gullets when they are removed from the carcass. Uses: Lard.

Ham facings: Fat of the internal crural region that is removed in facing or trimming the hams. Uses: Lard.

Pluck: The term properly includes larynx, trachea, esophagus, heart, lungs, liver, a portion of the diaphragm ("skirt"), and the fat of the parts. Sometimes the lungs alone are spoken of as plucks.

Livers: In test the liver is weighed before it has been trimmed of the gall bladder and ligamentous portions. Uses: When not used in liver sausage, it is tanked in the offal tank. Sometimes used in the manufacture of prepared chicken and dog feed.

Heart: Uses: Sausage.

Lungs: In test this refers to weight of lung tissue only; the mediastinal ("heart") fat having been trimmed away for lard purposes. Uses: Offal tank.

Bladders, gross: In test includes urine contained in bladder when removed, also attached fat.

Bladders, net: Weight of bladder when empty and trimmed of fat.

Bladder fat: Some of the pelvis fat ("crotch fat") is cut away with the neck of the bladder when it is removed from the carcass. Uses: Lard.

Total weight of guts: Weight of stomach, intestinal tube, intestinal contents, and attached fat.

Gut fat: Fat of the cecum and colon, together called the "black gut;" they are emptied, washed, and tanked. Uses: Lard.

Caul and ruffle: Caul fat means the fat of the omentum. Ruffle fat is the fat of the great and colic mesenteries. Uses: Lard.

Bung guts, gross: Weight of the posterior end of the intestinal tube (rectum and 4 to 6 feet of the colon), the intestinal contents, and the attached fat.

Bung guts, net: Weight of the bung guts after they have been emptied and the fat trimmed off. Uses: The bung gut is used for sausage casings.

Bung-gut fat: The fat that is trimmed from the bung guts. This includes the "knob fat," which is a bunch of fat about the size of a man's fist that is removed from the carcass with the anus. Uses: Lard.

Small guts, gross: Weight of duodenum, jejunum, ileum, their contents and fat attached.

Small guts, net: Weight of the duodenum, jejunum, and ileum after they have been emptied, washed, and trimmed. Uses: Sausage casings.

Paunches, gross: Weight of stomach and contents.

Paunches, net: Weight of stomachs after they have been emptied and trimmed. Uses: They are filled with lard or used for the casings of head cheese. Pepsin is manufactured from some portions, and they may be rendered in the lard tank.

Pig bags (uteri): Uses: Offal tank.

Head meat: Includes the "cheek meat," "skull meat," and the "temporal," or "pate," meat.

Cheek meat: Explained above.

Skull meat: Refers to the portions of the supra-cervical muscles, principally the rectuii copitii muscles, that remain attached to the parietal ridges of the occipital bone. Uses: Sausage.

Temporal, or pate, meat: Refers to the muscles filling the temporal fossa. Uses: Sausage.

Pizzle (penis): Uses: Offal tank.

Pouch: Prepuce and the surrounding bunch of connective tissue and fat. Uses: Offal tank.

Pizzle fat: Refers to the fat of the "pouch." Uses: Offal tank.

Kidney fat (leaf lard): Uses: Lard.

Crotch fat: Refers to the intra-pelvic fat. Uses: Lard.

Weasand (esophagus): Uses: Grease tank.

Weasand meat: Muscular portion of the esophagus. Uses: Of hogs not saved, grease tank.

Stomach lining: Refers to the mucous membrane of the cardiac end of the stomach from which pepsin is made.

Chitterling (cecum): Uses: Some people cook it. Usually tanked in offal tank.

Snouts: Refers to the nose and portion of the upper lip. Uses: Pickled for food.

Sweetbreads: In hogs this refers to the pancreas only. Uses: Sometimes cooked for food. In the packing house they are usually consigned to the lard tank.

Giblets, or giblet trimmings: Refers to that portion of the pillars of the diaphragm that is cut away with the pluck when it is removed. Uses: Sausage.

Gut scrapings: Refers to the mucous membrane lining of the intestines that is scraped away in preparing casings. May include small portion of the ruffle fat that is unintentionally left on the gut. Uses: Offal tank.

Feet: Uses: Boiled and pickled for food.

Brains: Uses: Cooked for food.

Tails: Uses: Cooked for food.

Blood: Uses: As food, in the arts, in the manufacture of albumen, or for fertilizer.

STATISTICS OF PRODUCTION AND TRADE.

STATISTICS OF PRODUCTION AND TRADE.

THE CENSUS RETURNS.

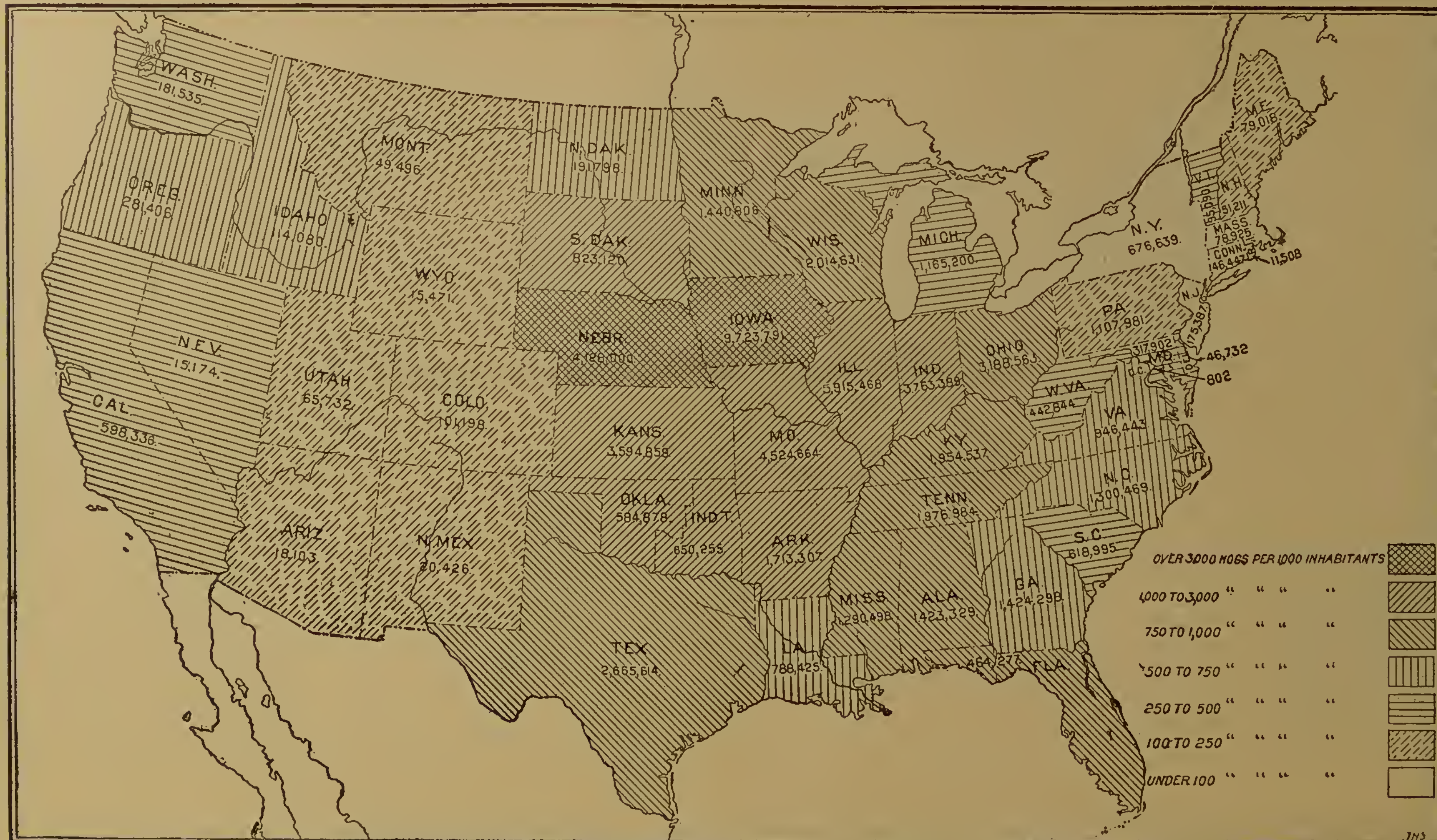
The Twelfth Census reports the total number of hogs on farms and ranges in the United States on June 1, 1900, excluding Alaska and Hawaii, as 62,868,041, with an estimated total value of $231,978,031. This is a ratio of 827 hogs per 1,000 inhabitants. "In the collection of the statistics of live stock, tabulated in the census of agriculture for 1900, three schedules were used. The first of these, known as the general farm schedule, was used by the enumerators in collecting data from the operators of farms, plantations, and ranges in all parts of the country. The second schedule was used by the special agents in recording the statistics of the larger ranches of the great West and Southwest, especially those making use of the range or public domain in sparsely settled sections of the country, where they might have been overlooked by the enumerators, or from which imperfect reports were likely to have been obtained. The third schedule was used by enumerators in collecting reports of domestic animals not on farms or ranges, especially those found in cities and villages." The foregoing figures are those of hogs on farms and ranges. This was 97.2 per cent of the total number reported. Those "in barns and inclosures elsewhere" were 1,818,114. There were 10 hogs on farms and ranges in Alaska, with an average value of $10 each, and 8,057 on farms and ranges in Hawaii, with an average value of $6.15 each.

The following table shows the returns for hogs for the United States, by States and Territories, the ratio to population, to land area and to farm area, and the average and total valuations. The farm areas used in calculating the figures in the fifth column were those reported by the Census Office, which defined a farm under the Twelfth Census as including "all the land under one management used for raising crops and pasturing live stock, with the wood lots, swamps, meadows, etc., connected therewith. It includes also the house in which the farmer resides, and all other buildings used by him in connection with his farming operations."

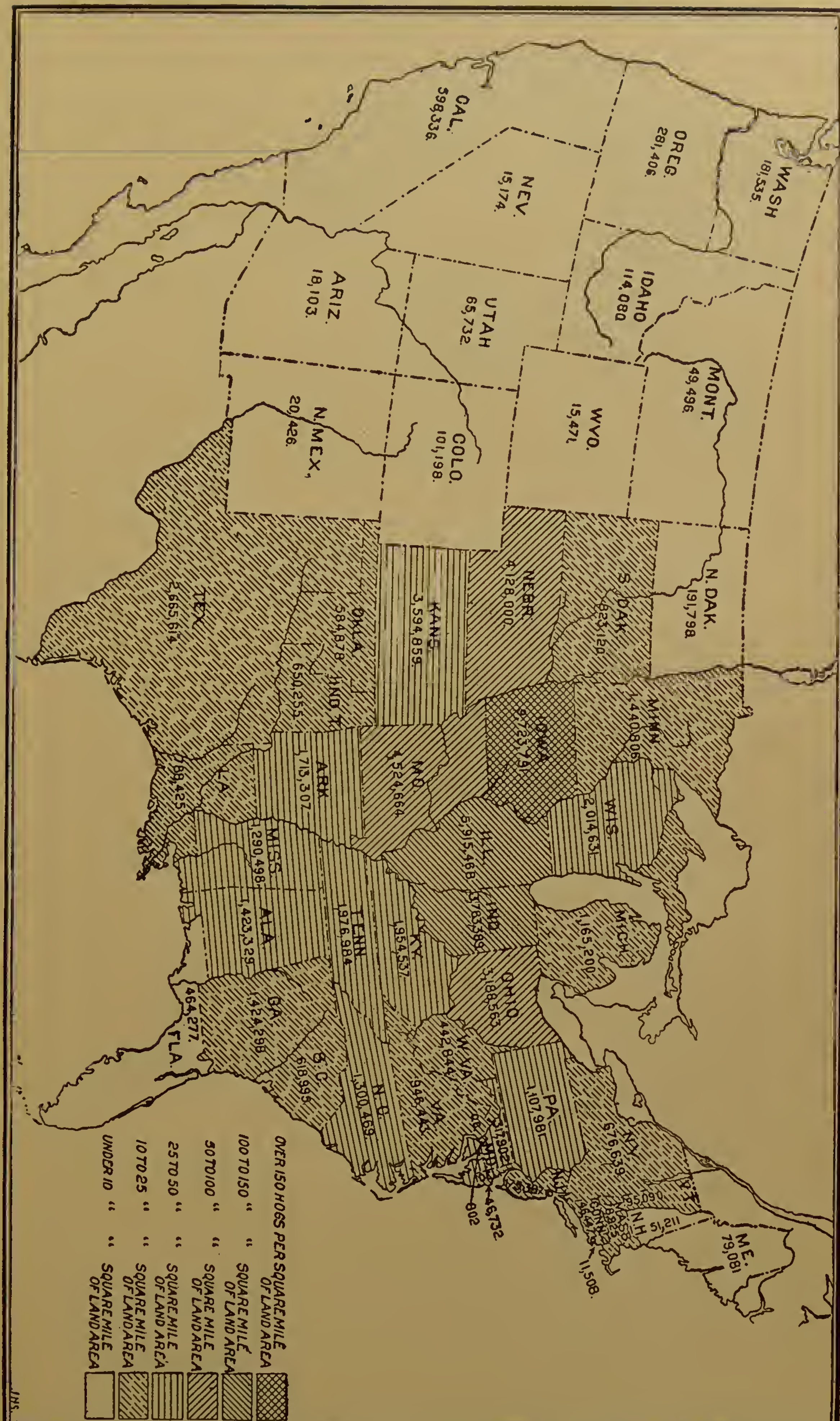
Hogs on farms and ranges in the United States in 1900.[a]

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
United States	62,868,041	827	21	48	$3.69	$231,978,031
North Atlantic division	2,322,206	110	14	23	5.60	13,011,651
Maine	79,018	114	3	8	6.53	516,015
New Hampshire	51,211	124	6	9	6.98	357,573
Vermont	95,090	277	10	13	6.52	620,169
Massachusetts	78,925	28	10	16	6.96	549,617
Rhode Island	11,508	27	11	16	7.87	90,614
Connecticut	46,447	51	10	13	7.04	326,857
New York	676,639	93	14	19	5.61	3,794,332
New Jersey	175,387	93	23	40	5.28	926,179
Pennsylvania	1,107,981	176	25	37	5.26	5,830,295
South Atlantic division	5,562,762	533	21	34	2.29	12,738,747
Delaware	46,732	253	24	28	5.02	234,472
Maryland	317,902	268	32	39	4.18	1,329,143
District of Columbia	802	3	13	60	5.11	4,097
Virginia	946,443	510	24	30	2.72	2,572,524
West Virginia	442,844	462	18	27	3.14	1,389,808
North Carolina	1,300,469	687	27	37	1.94	2,516,410
South Carolina	618,995	462	21	28	2.28	1,411,516
Georgia	1,424,298	643	24	35	1.81	2,577,950
Florida	464,277	878	9	68	1.51	702,827
North Central division	40,474,289	1,537	54	82	4.15	167,776,242
Ohio	3,188,563	767	78	83	3.70	11,813,168
Indiana	3,763,389	1,496	105	111	3.67	13,804,893
Illinois	5,915,468	1,227	106	115	3.99	23,616,781
Michigan	1,165,200	481	20	42	3.94	4,588,898
Wisconsin	2,014,631	974	37	65	3.76	7,580,423
Minnesota	1,440,806	823	18	35	4.07	5,865,590
Iowa	9,723,791	4,357	175	180	4.50	43,764,176
Missouri	4,524,664	1,456	66	85	3.65	16,533,935
North Dakota	191,798	601	3	8	4.85	930,470
South Dakota	823,120	2,050	11	28	4.30	3,540,072
Nebraska	4,128,000	3,871	54	88	4.52	18,660,932
Kansas	3,594,859	2,445	44	55	4.75	17,076,904
South Central division	13,047,827	927	21	32	2.47	32,233,204
Kentucky	1,954,537	910	49	57	2.65	5,176,183
Tennessee	1,976,984	978	47	62	2.45	4,838,713
Alabama	1,423,329	778	28	44	2.03	2,887,230
Mississippi	1,290,498	832	28	45	2.30	2,963,573
Louisiana	788,425	571	17	46	1.90	1,494,284
Texas	2,665,614	874	10	14	2.85	7,605,687
Oklahoma	584,878	1,468	15	24	4.07	2,380,025
Indian Territory	650,255	1,659	21	57	2.93	1,906,200
Arkansas	1,713,307	1,306	32	66	1.74	2,981,309

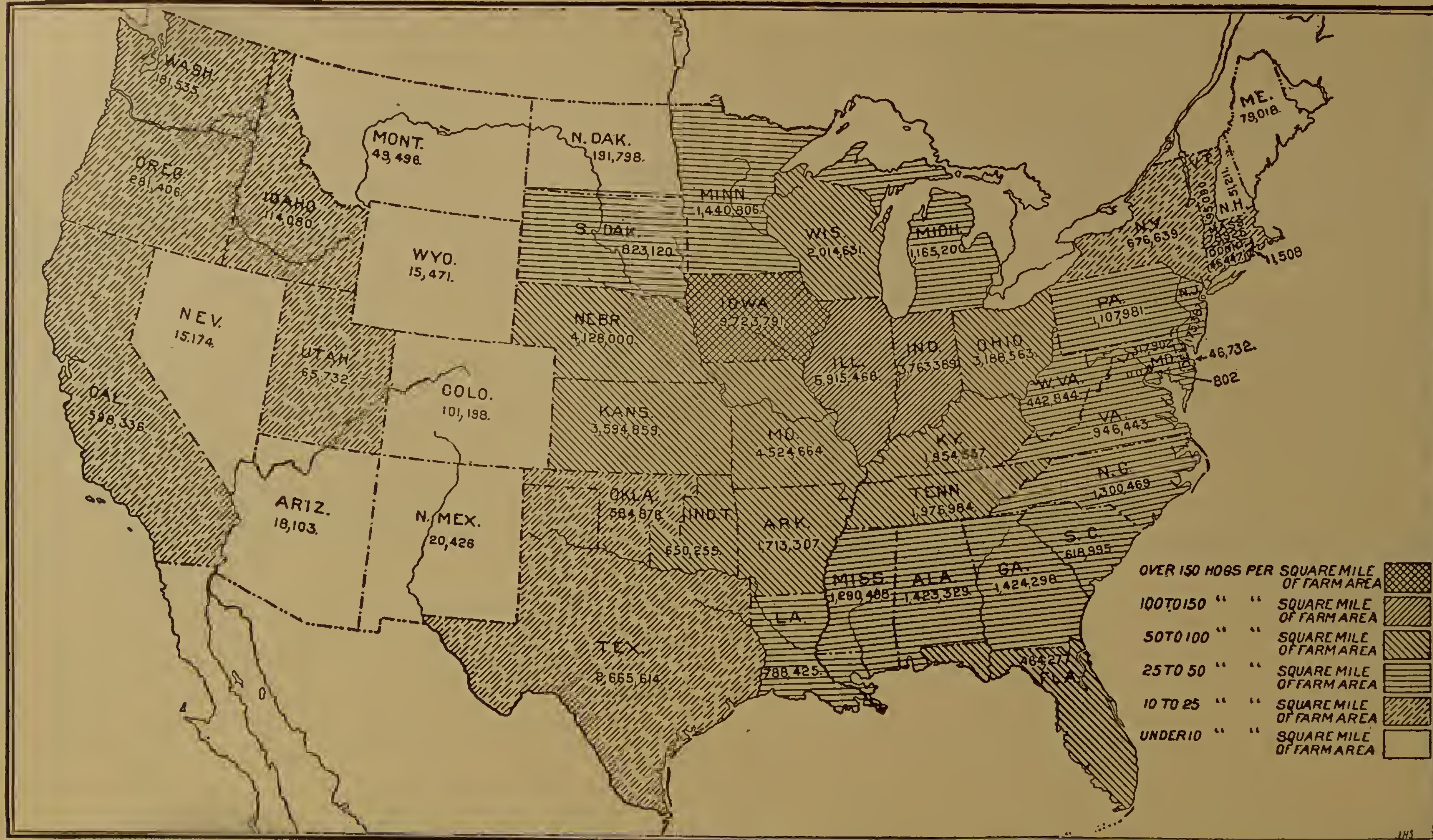
[a] Excluding Alaska and Hawaii.



Number of Hogs in Each State and Ratio Per 1,000 Population (Census of 1900).



NUMBER OF HOGS IN EACH STATE AND RATIO PER SQUARE MILE OF LAND AREA (CENSUS OF 1900).



NUMBER OF HOGS IN EACH STATE AND RATIO PER SQUARE MILE OF FARM AREA (CENSUS OF 1900).

Hogs on farms and ranges in the United States in 1900—Continued.

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
Western division	1,460,957	357	1	10	$4.26	$6,218,187
Montana	49,496	203	.3	3	5.69	281,402
Wyoming	15,471	167	.2	1	5.05	78,145
Colorado	101,198	188	1	7	4.77	482,722
New Mexico	20,426	105	.2	3	4.00	81,645
Arizona	18,103	147	.2	6	4.45	80,587
Utah	65,732	238	1	10	4.46	293,115
Nevada	15,174	358	.1	4	4.99	75,712
Idaho	114,080	705	1	23	4.21	480,338
Washington	181,535	350	3	14	4.58	830,704
Oregon	281,406	680	3	18	3.76	1,057,037
California	598,336	403	4	13	4.14	2,476,781

The following table shows the same facts as the preceding one, but the States are arranged so as to show particularly the overwhelming production of hogs in the corn belt. The arrangement was made with the view to grouping the States, as nearly as possible, according to (1) crops produced and climatic conditions, (2) the character of the hogs raised, and (3) proximity to market:

Hog production in the United States as related to crops, climate, and markets.

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
United States	62,868,041	827	21	48	$3.69	$231,978,031
The East and New England:						
Maine	79,018	114	3	8	6.53	516,015
New Hampshire	51,211	124	6	9	6.98	357,573
Vermont	95,090	277	10	13	6.52	620,169
Massachusetts	78,925	28	10	16	6.96	549,617
Rhode Island	11,508	27	11	16	7.87	90,614
Connecticut	46,447	51	10	13	7.04	326,857
New York	676,639	93	14	19	5.61	3,794,332
New Jersey	175,387	93	23	40	5.28	926,179
Pennsylvania	1,107,981	176	25	37	5.26	5,830,295
Delaware	46,732	253	24	28	5.02	234,472
Maryland	317,902	268	32	39	4.18	1,329,143
District of Columbia	802	3	13	60	5.11	4,097
Total	2,687,642	118	15	24	5.42	14,579,363
The South:						
Virginia	946,443	510	24	30	2.72	2,572,524
North Carolina	1,300,469	687	27	37	1.94	2,516,410
South Carolina	618,995	462	21	28	2.28	1,411,516
Georgia	1,424,298	643	24	35	1.81	2,577,950

Hog production in the United States as related to crops, etc.—Continued.

States and Territories.	Total number.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.	Total value.
The South—Continued.						
Florida	464,277	878	9	68	$1.51	$702,827
Alabama	1,423,329	778	28	44	2.03	2,887,230
Mississippi	1,290,498	832	28	45	2.30	2,963,573
Louisiana	788,425	571	17	46	1.90	1,494,284
Arkansas	1,713,307	1,306	32	66	1.74	2,981,369
Tennessee	1,976,984	978	47	62	2.45	4,838,713
Kentucky	1,954,537	910	49	57	2.65	5,176,183
West Virginia	442,844	462	18	27	3.14	1,389,808
Total	14,344,406	754	27	44	2.20	31,512,327
The southwest range States:						
Indian Territory	650,255	1,659	21	57	2.93	1,906,200
Oklahoma	584,878	1,468	15	24	4.07	2,380,025
Texas	2,665,614	874	10	14	2.85	7,605,687
New Mexico	20,426	105	.2	3	4.00	81,644
Arizona	18,103	147	.2	6	4.45	80,587
Total	3,939,276	948	7	16	3.06	12,054,143
The corn belt:						
Missouri	4,524,664	1,456	66	85	3.65	16,533,935
Kansas	3,594,859	2,445	44	55	4.75	17,076,904
Nebraska	4,128,000	3,871	54	88	4.52	18,660,932
Iowa	9,723,791	4,357	175	180	4.50	43,764,176
Illinois	5,915,468	1,227	106	115	3.99	23,616,781
Indiana	3,763,389	1,496	105	111	3.67	13,804,893
Ohio	3,188,563	767	78	83	3.70	11,813,168
Total	34,838,734	1,799	84	102	4.17	145,270,789
States north of the corn belt:						
Michigan	1,165,200	481	20	42	3.94	4,588,898
Wisconsin	2,014,631	974	37	65	3.76	7,580,423
Minnesota	1,440,806	823	18	35	4.07	5,865,590
North Dakota	191,798	601	3	8	4.85	930,470
South Dakota	823,120	2,050	11	28	4.30	3,540,072
Total	5,635,555	809	17	37	3.99	22,505,453
The northwest range States:						
Montana	49,496	203	.3	3	5.69	281,402
Wyoming	15,471	167	.2	1	5.05	78,145
Colorado	101,198	188	1	7	4.77	482,722
Utah	65,732	238	1	10	4.46	293,115
Nevada	15,174	358	.1	4	4.99	75,712
Idaho	114,080	705	1	23	4.21	480,338
Total	361,151	266	.6	6	4.68	1,691,434
The Pacific coast:						
Washington	181,535	350	3	14	4.58	830,704
Oregon	281,406	680	3	18	3.76	1,057,037
California	598,336	403	4	13	4.14	2,476,781
Total	1,061,277	439	3	14	4.11	4,364,522

An examination of these tables shows that in point of numbers Iowa leads, with 9,723,791; Illinois is second, with 5,915,468. There are four States—Iowa, Illinois, Missouri, and Nebraska—with over 4,000,000 hogs, and nineteen that have over 1,000,000; seventeen States and Territories have from 100,000 to 1,000,000 hogs; fourteen have less than 100,000; and Rhode Island, the District of Columbia, New Mexico, Arizona, Wyoming, and Nevada have less than 25,000.

The proportion of hogs to population has a direct bearing on the supply of pork in relation to consumption. On this point we find that Iowa has 4,357 hogs per 1,000 inhabitants, Nebraska being next with 3,871 per 1,000 inhabitants. Eight other States have over 1,000 hogs per 1,000 inhabitants; nine have from 750 to 1,000 hogs per 1,000 inhabitants; and sixteen have more than the average for the nation, which is 827. Fifteen States and Territories have fewer than 250 hogs per 1,000 inhabitants, and six have fewer than 100.

The ratios to land and farm area bear directly on the productive capacity of the country. The third column shows this ratio for the land area regardless of the state of cultivation, including, of course, considerable uninhabitable land. Iowa leads with 175 hogs per square mile, Illinois and Indiana having 106 and 105, respectively. In addition to these States, Missouri, Nebraska, and Ohio have over 50 hogs per square mile; twenty-two States and Territories have a number equal to or exceeding 21, the average for the entire country; fifteen have less than 10 hogs per square mile.

The next column more nearly shows the actual production of hogs by the farms than the preceding one dealing with the land area. Iowa again leads, with 180 hogs per square mile, Illinois and Indiana being second and third, with 115 and 111, respectively. In addition to these States eleven have over 50 hogs per square mile of farm area. No others are above the average for the nation—48. Nine States and Territories have fewer than 10 hogs per square mile of farm area.

The State of Rhode Island reports the highest average value, $7.87; Connecticut is second, with $7.04. The Southern States report the lowest average values, which, in spite of the fact that they have large numbers, brings the total values down. For instance, New York has 676,639 hogs, with a total value of $3,794,332; while Georgia, with 1,424,298, Alabama, with 1,423,329, and Arkansas, with 1,713,307, have each over twice as many hogs as New York, but the total values are considerably less, being 21.44 per cent less in the case of Arkansas, 23.90 per cent less in the case of Alabama, and 32.05 per cent less in the case of Georgia.

In considering the groups in the second table the predominance of those States that are particularly corn-growing districts is at once apparent. This group of seven States has 34,838,734 hogs, which is 55.39 per cent of the total on farms and ranges in the United States. The ratio per 1,000 inhabitants is 1,799—twice as great as the aver-

age; the ratio per square mile of land area is 84—four times the average for the entire country; and the ratio per square mile of farm area is 102—twice the general average. In average valuation alone the corn belt fails to lead the nation.

The States that form the southwestern range follow the corn-belt States in ratio per 1,000 inhabitants, this being 948, but are low in ratio per square mile of land and farm area. The other groups follow in this order: The States north of the corn belt, with 809 per 1,000 inhabitants; the South, with 754 per 1,000 inhabitants; the Pacific coast, with 439 per 1,000 inhabitants; the northwestern range States, with 266 per 1,000 inhabitants; the East, with 118 per 1,000 inhabitants. In ratios per square mile of land area the corn belt leads with 84, the other groups following thus: The South, with 27; States north of the corn belt, with 17; the East, with 15; the Southwest, with 7; the Pacific coast, with 3; the Northwest, with 0.6. In ratio per square mile of farm area the order is as follows: The corn belt, 102; the South, 44; States north of the corn belt, 37; the East, 24; the Southwest, 16; the Pacific coast, 14; the Northwest, 6. The Eastern States lead in average valuation, with $5.42; the northwestern range States second, with $4.68; the corn belt is third, with $4.17, and the remainder as follows: The Pacific coast, with $4.11; States north of the corn belt, with $3.99; the Southwest, $3.06; the South, $2.20.

The relative positions of these groups are consolidated into the following table:

Production of hogs in United States, by regions.

Group.	Total number on farms and ranges.	Ratio per 1,000 inhabitants.	Ratio per square mile, land area.	Ratio per square mile, farm area.	Average value.
Corn belt	First	First	First	First	Third.
South	Second	Fourth	Second	Second	Seventh.
States north of corn belt	Third	Third	Third	Third	Fifth.
Southwest	Fourth	Second	Fifth	Fifth	Sixth.
East	Fifth	Seventh	Fourth	Fourth	First.
Pacific coast	Sixth	Fifth	Sixth	Sixth	Fourth.
Northwest	Seventh	Sixth	Seventh	Seventh	Second.

TRADE STATISTICS.

THE DOMESTIC TRADE.

Before giving the following statistics it should be explained that the pork-packing year ends March 1 and is divided into two seasons—the summer season of eight months, from March 1 to November 1, and the winter season of four months, from November 1 to March 1. This system came into vogue before the days of artificial refrigeration, and, although such a designation is no longer necessary, it is

still adhered to by statisticians. The figures for packing in the West (packing centers in the corn belt or States contiguous to it) are much more accurate than those for the rest of the country, where reports of operations are not so completely published.

TOTAL COST OF HOGS SLAUGHTERED.

The Cincinnati Price Current reports the total cost of hogs purchased by Western packers during the year ended March 1, 1903, as $313 537,000. The approximate cost of hogs slaughtered in the East is estimated at $67,000,000, making a total of $380,537,000, which does not include the immense number of animals killed on small farms or in towns, for which there are no commercial reports and no means of making accurate estimates. This is 2.01 per cent less than the cost for the preceding year, but over 90.11 per cent greater than the cost for the year ended March 1, 1892. The following table shows these facts in detail for the past thirteen years:

Cost of hogs slaughtered annually.

Years.	Western packing.	Eastern slaughtering.	Total.	Years.	Western packing.	Eastern slaughtering.	Total.
1902–03	$313,537,000	$67,000,000	$380,537,000	1895–96	$142,268,000	$48,000,000	$190,268,000
1901–02	323,346,000	65,000,000	388,346,000	1894–95	172,679,000	56,000,000	228,679,000
1900–01	274,680,000	58,000,000	332,680,000	1893–94	166,090,000	64,000,000	230,090,000
1899–00	212,850,000	55,000,000	267,858,000	1892–93	155,766,000	69,000,000	224,766,000
1898–99	203,696,000	50,000,000	253,696,000	1891–92	141,698,000	58,000,000	199,698,000
1897–98	174,382,000	48,000,000	222,382,000	1890–91	158,445,000	52,000,000	210,445,000
1896–97	135,456,000	42,000,000	177,456,000	1889–90	134,169,000	47,000,000	181,169,000

YEARLY COMPARISONS OF PORK PACKING.

The following table shows, by seasons and total, the number of hogs packed in the West, the total amount of green meats and lard produced, and the total cost of hogs since the year ended March 1, 1872. It will be noticed that the year ended March 1, 1902, shows the greatest number of hogs packed during any of the years given, the greatest production of green meats, except for the year 1898–99, and the greatest amount of lard except for the years 1898–99 and 1900–01. The reason for these differences is apparent when reference is made to the table showing lard averages, where it is seen that the average weight of hogs sold during the winter season of 1901–02 was the least for any year reported. The rush of light, unfinished hogs to market during the drouth of 1901 and the succeeding period of high prices for feed was the cause of this falling off in weight. Comparing with the year ended March 1, 1892, we see that during the packing year of 1901–02 there were marketed 10,954,062 more hogs than during the

year 1891–92, an increase of 75 per cent; there were produced 1,098,097,000 pounds more of green meats and 324,084,000 pounds more of lard, increases of 55 per cent and 67 per cent, respectively:

Yearly comparisons of pork packing in the West.

[Cincinnati Price Current.]

Years.	Total number of hogs packed in the West.			Green meats produced.	Total lard produced.	Total cost of hogs.
	Summer season.	Winter season.	Year ended Mar. 1.			
	Number.	*Number.*	*Number.*	*Pounds.*	*Pounds.*	*Dollars.*
1872–73	505,500	5,410,314	5,915,814	955,390,000	224,810,000	64,135,000
1873–74	1,062,916	5,466,200	6,529,116	978,850,000	228,610,000	75,502,000
1874–75	1,200,444	5,566,226	6,766,670	903,847,000	231,180,000	112,943,000
1875–76	1,262,343	4,880,135	6,142,478	900,407,000	208,831,000	116,407,000
1876–77	2,307,866	5,101,308	7,409,174	1,068,450,000	243,919,000	115,965,000
1877–78	2,543,120	6,505,446	9,048,566	1,368,612,000	336,557,000	106,418,000
1878–79	3,378,044	7,480,648	10,858,792	1,579,311,000	408,702,000	94,980,000
1879–80	4,051,248	6,950,451	11,001,699	1,556,516,000	382,020,000	119,362,000
1880–81	5,323,898	6,919,456	12,243,354	1,694,253,000	409,875,000	134,944,000
1881–82	4,803,689	5,747,760	10,551,449	1,468,368,000	363,772,000	154,422,000
1882–83	3,210,787	6,132,212	9,342,999	1,315,056,000	316,063,000	154,100,000
1883–84	3,781,036	5,402,064	9,183,100	1,280,065,000	318,472,000	122,388,000
1884–85	4,058,868	6,460,240	10,519,108	1,497,357,000	364,375,000	124,754,000
1885–86	4,964,572	6,298,995	11,263,567	1,577,932,000	390,740,000	106,053,000
1886–87	5,644,003	6,439,009	12,083,012	1,619,126,000	394,118,000	119,935,000
1887–88	5,611,526	5,921,181	11,532,707	1,518,677,000	357,755,000	133,037,000
1888–89	5,315,122	5,483,852	10,798,974	1,499,251,000	359,927,000	140,903,000
1889–90	6,881,501	6,663,802	13,545,303	1,885,424,000	489,727,000	134,169,000
1890–91	9,540,008	8,173,126	17,713,134	2,371,376,000	618,732,000	158,445,000
1891–92	6,696,398	7,761,216	14,457,614	1,907,903,000	479,045,000	141,698,000
1892–93	7,757,110	4,633,520	12,390,630	1,557,111,000	388,985,000	155,766,000
1893–94	6,720,924	4,884,082	11,605,006	1,583,703,000	409,052,000	166,090,000
1894–95	8,812,125	7,191,520	16,003,645	2,072,195,000	533,055,000	172,679,000
1895–96	8,194,835	6,815,800	15,010,635	1,958,255,000	513,467,000	142,268,000
1896–97	9,979,888	6,949,090	16,928,978	2,250,158,000	662,040,000	135,456,000
1897–98	11,760,475	8,440,785	20,201,260	2,659,190,000	721,354,000	174,382,000
1898–99	13,931,550	9,720,145	23,651,695	3,030,000,000	808,473,000	203,696,000
1899–00	13,524,943	8,675,878	22,200,821	2,828,000,000	794,453,000	212,858,000
1900–01	14,322,924	9,277,750	23,600,674	2,983,000,000	805,703,000	274,682,000
1901–02	15,071,480	10,340,196	25,411,676	3,006,000,000	803,129,000	323,346,000
1902–03	12,146,965	8,458,606	20,605,571	2,579,000,000	650,707,000	313,507,000

WEIGHT, AND LARD AVERAGES.

The following table shows the average weight of hogs and the yield of lard in the West for the winter seasons ended March 1, since 1873. Note especially that, while the average weight has decreased from 290.53 pounds in 1873 to 206.38 pounds in 1902, and the yield of lard from 40.08 pounds per hog in the winter season ended March 1, 1873, to 31.30 for the winter season ended March 1, 1902, the percentage of lard yield per hog shows a slight increase.

Average live weight of hogs and yield of lard in the West for the winter seasons ended March 1.

[Cincinnati Price Current.]

Year.	Weight.	Lard.		Year.	Weight.	Lard.	
	Pounds.	*Pounds.*	*Per cent.*		*Pounds.*	*Pounds.*	*Per cent.*
1873	290.53	40.08	13.80	1889	263.46	34.76	13.19
1874	268.71	35.02	13.03	1890	250.92	36.37	14.49
1875	262.21	34.20	13.04	1891	239.75	33.45	13.95
1876	272.13	35.45	13.03	1892	247.64	34.69	14.01
1877	269.90	34.08	12.62	1893	227.73	31.66	13.90
1878	282.55	38.61	13.66	1894	248.20	36.07	14.53
1879	271.42	39.40	14.52	1895	232.73	33.62	14.45
1880	266.17	36.32	13.65	1896	240.71	35.53	14.76
1881	259.63	35.65	13.73	1897	244.80	36.94	15.09
1882	262.70	36.44	13.87	1898	235.35	34.73	14.76
1883	267.02	35.43	13.27	1899	232.65	35.53	15.27
1884	251.44	33.25	13.22	1900	235.67	35.97	15.26
1885	266.51	36.02	13.52	1901	230.31	34.16	14.83
1886	258.98	35.22	13.60	1902	206.38	31.30	15.17
1887	251.31	33.54	13.35	1903	224.05	31.92	14.42
1888	242.30	31.06	12.82				

YEARLY COST OF HOGS.

The following table shows the average cost of hogs for the seasons and years stated. Further on a table of highest prices of hogs is given which must not be confused with this one.

Average cost of hogs packed in the West, per hundred pounds live weight, for years ended March 1.

[Cincinnati Price Current.]

Year.	Summer.	Winter.	Average for year.	Year.	Summer.	Winter.	Average for year.
1880–81	$4.20	$4.61	$4.45	1892–93	$5.03	$6.54	$5.60
1881–82	5.65	6.06	5.90	1893–94	6.33	5.26	5.87
1882–83	7.20	6.28	6.65	1894–95	4.98	4.28	4.67
1883–84	5.60	5.18	5.35	1895–96	4.41	3.68	4.07
1884–85	5.35	4.29	4.70	1896–97	3.30	3.30	3.30
1885–86	3.90	3.66	3.75	1897–98	3.70	3.53	3.63
1886–87	4.10	4.19	4.15	1898–99	3.85	3.52	3.71
1887–88	4.75	5.04	4.90	1899–00	4.00	4.29	4.11
1888–89	5.58	4.99	5.26	1900–01	5.12	5.02	5.07
1889–90	4.30	3.66	3.98	1901–02	5.92	5.97	5.94
1890–91	3.91	3.54	3.74	1902–03	7.06	6.44	6.81
1891–92	4.48	3.91	4.16				

WINTER PACKING IN THE WEST.

The following table shows the total number of hogs packed in the West during the winter seasons, and cost of hogs per 100 pounds live weight since 1842. Before 1873, these figures represent practically

the total number of hogs packed in the West for the years given. Summer packing began in September of that year, when it is said to have reached the number of 505,500.

Number of hogs packed in the West during the winter seasons, and cost of hogs per 100 pounds live weight.

[Cincinnati Price Current.]

Season.	Number.	Cost.	Season.	Number.	Cost.
1902-03	8,458,606	$6.44	1871-72	4,831,558	$4.12
1901-02	10,340,196	5.97	1870-71	3,695,251	5.26
1900-01	9,277,750	5.02	1869-70	2,635,312	9.22
1899-00	8,675,898	4.29	1868-69	2,499,873	8.18
1898-99	9,720,145	3.52	1867-68	2,781,084	6.36
1897-98	8,440,785	3.53	1866-67	2,490,791	5.78
1896-97	6,949,090	3.30	1865-66	1,785,955	9.34
1895-96	6,815,800	3.68	1864-65	2,422,779	11.46
1894-95	7,191,520	4.28	1863-64	3,261,105	5.36
1893-94	4,884,082	5.26	1862-63	4,069,520	3.36
1892-93	4,633,520	6.64	1861-62	2,893,666	2.42
1891-92	7,761,216	3.91	1860-61	2,155,702	4.57
1890-91	8,173,126	3.54	1859-60	2,350,822	4.73
1889-90	6,663,802	3.66	1858-59	2,465,552	5.02
1888-89	5,483,852	4.99	1857-58	2,210,778	3.89
1887-88	5,921,181	5.04	1856-57	1,818,468	4.75
1886-87	6,439,009	4.19	1855-56	2,489,502	4.60
1885-86	6,298,995	3.66	1854-55	2,124,404	3.37
1884-85	6,460,240	4.29	1853-54	2,534,770	3.35
1883-84	5,402,064	5.18	1852-53	2,201,110	4.81
1882-83	6,132,212	6.28	1851-52	1,182,846	3.56
1881-82	5,747,760	6.06	1850-51	1,332,867	3.00
1880-81	6,919,456	4.64	1849-50	1,652,220	2.13
1879-80	6,950,451	4.18	1848-49	1,560,000	3.75
1878-79	7,480,648	2.85	1847-48	1,710,000	2.60
1877-78	6,505,446	3.99	1846-47	825,000	2.85
1876-77	5,101,308	5.74	1845-46	940,000	3.90
1875-76	4,880,135	7.05	1844-45	790,000	2.65
1874-75	5,566,226	6.66	1843-44	1,245,000	
1873-74	5,466,200	4.34	1842-43	675,000	
1872-73	5,410,314	3.73			

TOTAL PACKING IN THE EAST.

The next table gives the statistics for Eastern packing, but these figures do not include the consumption of hogs at New York, Baltimore, and Philadelphia. Returns of hogs packed at these cities are not available, and the number of hogs consumed is approximated by taking the receipts at these places. This gives a fair estimate, as comparatively few hogs are shipped out. It is seen at once that, while there was an almost constant yearly increase in the number of hogs packed in the East from 1882 to 1892, during the last decade (1892–1902) this number has been nearly constant or has shown a slight tendency to decrease. The receipts at the three cities of New York, Baltimore, and Philadelphia, shown in a later table, have a

similar tendency. If there has been the same relative decrease in average weight in the East that has been noted as a feature of the Western situation, which is not unreasonable to suppose, we may infer that pork production has decreased slightly in the East during the last ten years. The table embraces Boston, New Haven, Providence, Worcester, Brightwood, Fall River, Bridgeport, etc., in New England; Buffalo, Albany, Troy, Hudson, etc., in New York; and Pottsville, Harrisburg, Mount Carmel, Allentown, Chester, Coatesville, etc., in Pennsylvania.

Aggregate number of hogs packed in the East during the year ended March 1, for summer and winter seasons and for the year.

[Cincinnati Price Current.]

Year.	Summer.	Winter.	Twelve months.	Year.	Summer.	Winter.	Twelve months.
	Number.	*Number.*	*Number.*		*Number.*	*Number.*	*Number.*
1902–03	1,702,000	1,093,000	2,795,000	1891–92	1,658,409	1,113,754	772,163
1901–02	1,728,000	1,021,000	2,749,000	1890–91	1,473,961	1,036,200	2,540,161
1900–01	1,683,000	1,077,000	2,760,000	1889–90	1,378,520	959,813	2,338,333
1899–00	1,996,000	1,096,000	3,092,000	1888–89	1,231,069	859,494	2,090,563
1898–99	1,895,000	1,269,000	3,164,000	1887–88	1,306,849	951,708	2,258,557
1897–98	1,883,600	1,188,500	3,072,100	1886–87	1,113,410	807,115	1,920,525
1896–97	1,659,800	1,131,100	2,790,900	1885–86	991,448	687,810	1,679,258
1895–96	1,546,500	1,056,000	2,602,500	1884–85	935,238	614,516	1,549,754
1894–95	1,863,000	1,235,500	3,098,500	1883–84	848,153	628,294	1,476,447
1893–94	1,638,205	1,063,029	2,701,234	1882–83	824,031	509,071	1,333,102
1892–93	1,989,720	1,026,310	3,016,030				

VISIBLE MARKETING OF HOGS.

The following compilation shows the comparative visible marketing of hogs for years ended March 1, as indicated by Western and Eastern packing returns and receipts at New York, Philadelphia, and Baltimore:

Visible marketing of hogs, 1879–1903.

[Cincinnati Price Current.]

Year.	Western packing.	Eastern packing.	Receipts at 3 cities.	Total.
	Number.	*Number.*	*Number.*	*Number.*
1879–80	11,002,000	1,154,000	2,673,000	14,829,000
1880–81	12,243,000	1,209,000	2,701,000	16,153,000
1881–82	10,551,000	1,005,000	2,915,000	14,471,000
1882–83	9,343,000	1,333,000	2,450,000	13,126,000
1883–84	9,183,000	1,476,000	2,594,000	13,253,000
1884–85	10,519,000	1,550,000	2,658,000	14,727,000
1885–86	11,264,000	1,679,000	2,883,000	15,826,000
1886–87	12,083,000	1,995,000	2,905,000	16,983,000
1887–88	11,533,000	2,258,000	2,599,000	16,390,000
1888–89	10,799,000	2,091,000	2,760,000	15,650,000
1889–90	13,545,000	2,338,000	3,023,000	18,906,000

Visible marketing of hogs, 1879–1903—Continued.

Year.	Western packing.	Eastern packing.	Receipts at 3 cities.	Total.
	Number.	*Number.*	*Number.*	*Number.*
1890–91	17,713,000	2,540,000	3,713,000	23,966,000
1891–92	14,457,000	2,771,000	3,684,000	20,912,000
1892–93	12,390,000	3,016,000	2,790,000	18,196,000
1893–94	11,605,000	2,701,000	2,483,000	16,789,000
1894–95	16,003,000	3,099,000	2,517,000	21,619,000
1895–96	15,010,000	2,603,000	2,867,000	20,480,000
1896–97	16,929,000	2,791,000	2,950,000	22,670,000
1897–98	20,201,000	3,072,000	2,861,000	25,134,000
1898–99	23,651,000	3,164,000	2,978,000	29,793,000
1899–00	22,201,000	3,092,000	2,879,000	28,172,000
1900–01	23,600,000	2,760,000	2,620,000	28,980,000
1901–02	25,411,000	2,749,000	2,235,000	30,395,000
1902–03	20,605,000	2,795,000	1,840,000	25,245,000

Commenting on these figures, the Price Current calls attention to the fact that it is difficult to estimate satisfactorily the number of hogs slaughtered in the country—on farms, etc.—which are not included in the above figures, but it is likely this number has been 10,000,000 or more each year in late years, bringing the aggregate slaughtering up to approximately 40,000,000 for the entire country in years of larger operations, in periods of most plentiful supplies.

LARD PRODUCTION COMPARISONS.

The total lard production of western packing for years ended March 1, and also for the packing at eastern cities, and from hogs slaughtered at New York, Baltimore, and Philadelphia, are shown in the following:

Production of lard, 1880–1903.

[Cincinnati Price Current.]

Year.	Western packing.	Other production.	Total.	Year.	Western packing.	Other production.	Total.
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
1880–81	409,875,000	107,785,000	517,660,000	1892–93	388,985,000	145,000,000	533,985,000
1881–82	363,772,000	105,157,000	468,929,000	1893–94	409,052,000	130,000,000	539,052,000
1882–83	316,063,000	103,450,000	419,513,000	1894–95	533,055,000	140,000,000	673,055,000
1883–84	318,472,000	125,978,000	444,450,000	1895–96	513,467,000	136,000,000	649,467,000
1884–85	364,376,000	116,029,000	480,405,000	1896–97	662,040,000	143,500,000	805,540,000
1885–86	390,741,000	123,489,000	514,230,000	1897–98	721,354,000	148,000,000	869,354,000
1886–87	394,118,000	132,914,000	527,032,000	1898–99	808,473,000	153,000,000	961,473,000
1887–88	357,755,000	129,424,000	487,179,000	1899–00	794,453,000	150,000,000	944,453,000
1888–89	359,927,000	123,975,000	483,902,000	1900–01	805,703,000	135,000,000	940,703,000
1889–90	489,727,000	134,500,000	624,227,000	1901–02	803,129,000	125,000,000	928,129,000
1890–91	618,732,000	156,300,000	775,032,000	1902–03	650,707,000	115,000,000	765,707,000
1891–92	479,000,000	163,000,000	642,000,000				

THE FOREIGN TRADE.

EXPORTS OF HOGS AND HOG PRODUCTS.

The following figures show the export trade in hogs and hog products, by countries, for the past three fiscal years ended June 30. The most striking feature of our foreign trade is the almost complete predominance of exports. This is so great that, except for bristles, the imports have not received separate enumeration by the Treasury Department. The balance of trade in bristles is still in favor of foreign countries:

Exports of hogs and hog products during three years, 1901–1903.

[Bureau of Statistics, Treasury Department.]

Article and country of import.	1901.		1902.		1903.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
Hogs exported to—	*Number.*	*Dollars.*	*Number.*	*Dollars.*	*Number.*	*Dollars.*
British North America	1,427	12,886	2,352	17,535	1,318	11,608
Mexico	2,904	32,709	2,002	25,939	1,191	11,470
West Indies and Bermuda	17,920	191,772	3,951	43,779	1,223	15,295
South America	14	255	33	885		
Asia and Oceania	6	250			17	366
Other countries	47	593	30	192	282	2,184
Total	22,318	238,465	8,368	88,330	4,031	40,923
	Gallons.		*Gallons.*		*Gallons.*	
Lard oil	766,783	438,645	460,035	327,794	356,658	306,334
Bacon exported to—	*Pounds.*		*Pounds.*		*Pounds.*	
United Kingdom	369,082,490	30,884,512	310,380,793	28,927,610	162,549,709	17,572,088
Belgium[a]			21,361,704	1,941,997	11,349,214	1,131,406
France	2,755,224	196,782	845,484	75,048	447,546	44,796
Germany	18,394,390	1,386,055	20,009,656	1,675,155	13,705,305	1,339,119
Netherlands[a]			5,736,628	499,230	3,764,141	385,211
Other Europe	51,340,500	3,758,615	38,208,232	3,393,449	4,761,205	479,095
British North America	4,524,858	435,964	5,778,031	621,958	4,179,619	474,302
Central American States and British Honduras	323,465	29,608	319,766	29,888	250,919	26,795
Mexico	303,728	32,733	291,747	32,890	241,699	32,775
Santo Domingo	21,049	1,944	13,062	1,302		
Cuba	5,687,413	456,456	4,111,136	364,536	3,346,240	345,233
Porto Rico[b]						
Other West Indies and Bermuda	380,530	39,086	367,206	41,747	357,117	49,033
Brazil	2,456,927	191,186	1,908,467	181,708	1,774,305	213,199
Colombia	19,331	1,776	23,271	2,204	28,066	3,181
Other South America	311,350	27,357	319,153	33,368	154,991	17,773
Chinese Empire	170,487	23,400	118,158	17,976	95,157	16,233
Hawaii[b]						

[a] Included in "Other Europe" prior to 1902.

[b] The commerce between the United States and Hawaii and Porto Rico, respectively, is not included in the statements of the foreign trade of the United States after June 30, 1900, but after this date the trade of Hawaii, and after July 1, 1901, of Porto Rico, with foreign countries is included in the statement of the domestic commerce of the United States.

Exports of hogs and hog products during three years, 1901–1903—Continued.

Article and country of import.	1901.		1902.		1903.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
Bacon exported to—Con.	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
Philippine Islands	1,015	152	79,022	9,922	37,918	6,207
Other Asia and Oceania	117,552	15,662	109,575	16,708	182,082	30,508
Africa	223,432	17,738	267,865	24,328	110,767	11,571
Total	456,122,741	37,499,026	383,150,624	35,449,797	207,336,000	22,178,525
Hams exported to—						
United Kingdom	191,127,894	20,269,042	202,390,263	22,569,633	189,026,769	22,797,301
Belgium[a]	-----	-----	6,648,096	674,814	3,814,913	411,308
France	667,119	65,310	180,041	18,572	135,740	14,843
Germany	2,156,646	218,758	2,128,576	219,826	1,143,210	116,658
Netherlands[a]	-----	-----	2,271,815	233,515	1,506,088	158,022
Other Europe	8,990,373	883,689	9,820,647	1,003,123	2,128,325	243,501
British North America	2,770,198	302,793	3,480,795	375,436	7,720,075	896,608
Central American States and British Honduras	324,484	34,603	273,098	31,088	228,239	29,491
Mexico	422,185	49,628	476,172	58,690	488,523	64,699
Santo Domingo	103,412	13,397	88,513	11,809	-----	-----
Cuba	6,261,019	595,776	5,576,814	554,590	4,719,571	542,695
Porto Rico[b]	-----	-----	-----	-----	-----	-----
Other West Indies and Bermuda	1,923,525	190,428	1,672,575	184,677	1,565,887	205,782
Brazil	50,518	5,921	29,171	3,269	17,854	2,286
Colombia	179,669	18,023	152,210	16,164	116,630	14,531
Other South America	682,310	83,510	599,733	77,154	626,771	82,347
Chinese Empire	260,556	34,671	166,615	24,137	220,297	34,925
British Australasia	83,684	8,173	2,787	272	33,934	4,207
Hawaii[b]	-----	-----	-----	-----	-----	-----
Philippine Islands	68,212	8,756	201,264	24,475	100,562	13,495
Other Asia and Oceania	275,011	36,791	212,216	28,464	251,814	37,206
Africa	197,280	20,798	181,433	18,956	314,943	39,637
Other countries	27,713	2,711	20,309	2,409	23,220	3,031
Total	216,571,803	22,842,778	227,653,232	25,222,744	214,183,365	25,712,633
Pork:						
Canned	8,945,594	708,381	9,603,882	832,910	13,590,897	1,369,687
Fresh	30,728,586	2,424,537	44,171,674	3,652,464	20,966,113	2,035,491
Salted or pickled	138,643,611	9,926,633	115,896,275	10,117,562	95,287,374	9,959,762
Total fresh and salted	169,372,197	12,351,170	160,067,949	13,770,026	116,253,487	11,995,253
Exported to—						
United Kingdom	88,731,438	6,830,647	98,504,537	8,641,863	71,497,640	7,592,301
Belgium[a]	-----	-----	6,047,148	520,219	3,915,839	402,417
France	111,925	7,196	78,000	6,750	89,300	8,851
Germany	9,830,423	655,697	8,671,775	719,438	2,896,130	270,437
Netherlands[a]	-----	-----	8,277,773	714,704	2,767,981	284,633
Other Europe	30,451,098	2,096,818	21,834,445	1,860,467	6,651,407	667,249
British North America	10,241,105	668,047	9,935,122	754,852	9,698,420	917,802

[a] Included in "Other Europe" prior to 1902.

[b] See note b, page 259.

Exports of hogs and hog products during three years, 1901–1903—Continued.

Article and country of import.	1901.		1902.		1903.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
Pork—Continued.	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
Exported to—						
Central American States and British Honduras	1,532,495	107,511	1,319,601	107,536	1,407,465	131,543
Santo Domingo	135,490	10,042	110,842	9,594		
Cuba	7,902,577	587,849	5,734,050	491,486	2,902,606	270,016
Porto Rico [a]						
Other West Indies and Bermuda	15,634,141	1,047,020	10,069,824	853,084	8,151,649	806,051
Brazil	3,800	262	19,600	1,900	188,050	19,255
Colombia	229,332	17,292	194,762	16,588	129,060	12,386
Other South America	4,006,308	281,899	3,278,446	278,115	3,097,524	301,266
Philippine Islands			9,800	950	17,913	2,045
Other Asia and Oceania	96,635	7,768	76,035	6,600	1,223,622	122,785
Africa	166,300	11,675	119,800	10,365	1,528,055	176,737
Other countries	299,130	21,447	111,310	10,438	90,826	9,479
Total	169,372,197	12,351,170	160,067,949	13,770,026	116,253,487	11,995,253
Lard exported to—						
United Kingdom	211,264,628	16,377,255	199,442,907	19,019,841	196,458,773	20,747,232
Belgium [b]			30,404,880	2,874,757	23,702,251	2,413,561
France	15,471,922	1,148,518	7,801,007	691,981	4,346,321	427,708
Germany	182,389,879	13,700,875	173,269,658	16,237,434	148,962,391	15,448,598
Italy [a]			2,348,733	222,845	3,375,019	351,265
Netherlands [a]			53,269,049	5,060,486	42,002,215	4,470,418
Other Europe	112,222,710	8,434,928	108,040,377	10,147,575	18,925,350	1,900,150
British North America	3,321,798	270,609	1,737,936	175,156	1,389,844	141,840
Central American States and British Honduras	2,551,001	203,598	1,756,920	170,670	1,487,472	144,779
Mexico	6,937,766	454,040	8,098,615	702,082	3,448,455	320,691
Santo Domingo	506,279	40,571	471,934	46,355		
Cuba	38,304,327	2,811,696	25,374,052	2,144,229	20,379,728	1,812,639
Porto Rico [b]						
Other West Indies and Bermuda	6,749,150	529,887	5,904,362	543,697	7,281,986	676,513
Argentina	107,893	9,218	68,195	7,028	40,471	4,414
Brazil	12,938,329	1,124,619	10,194,268	1,059,556	6,018,988	688,236
Chile [c]			413,285	45,868	546,222	60,197
Colombia	1,480,890	115,264	1,145,374	98,995	1,910,567	176,260
Venezuela [c]			4,014,964	418,767	2,467,088	243,675
Other South America	12,703,416	1,001,679	9,058,826	890,548	4,056,847	385,777
Hawaii [b]						
Philippine Islands	77,255	6,975	211,821	19,700	135,471	14,761
Other Asia and Oceania	2,103,855	148,827	744,073	67,541	1,094,727	114,506
Africa	2,155,971	176,812	3,465,662	348,519	2,696,205	308,080
Other countries	70,445	4,777	54,235	4,957	29,430	3,204
Total	611,357,514	46,560,148	556,840,222	52,375,864	490,755,821	50,854,504

[a] Included in "Other Europe" prior to 1902.
[b] Omitted as part of foreign traffic of United States after June 30, 1900.
[c] Included in "Other South America" prior to 1902.

The export trade in live hogs is not an important factor of the industry, and the tendency on the part of dealers to ignore it is evident, especially when these figures are compared with those in the next table, which show exports since 1790. The greater proportion of live hogs exported go to the West Indies and Bermuda, Mexico, and British America.

The quantities of lard oil exported during the fiscal year ended June 30, 1903, were considerably less than those of 1902, and decidedly so as compared with 1901.

In exports of hog products bacon first commands our attention. It is noteworthy that there has been a very large decrease in the quantities exported during the last three years, but there is not the same decrease in total values; indeed, the latter have remained practically stationary. This is due, of course, to the rapid rise in domestic prices, which has also had much to do with the falling off in the foreign demand.

In all kinds of meat products of hogs the United Kingdom is our best customer. In bacon Germany stands second, but during the period under consideration Great Britain and Ireland purchased from twelve to twenty times as much bacon as Germany. Since being separately reported, Belgium shows purchases of bacon fully as large as those of Germany.

Hams show an increase from 196,414,412 pounds in 1900, valued at $20,416,367, to 227,653,232 pounds in 1902, valued at $25,222,744, but a decrease to 214,183,365 pounds in 1903, valued at $25,712,633. The purchases of United States hams by the United Kingdom form about 85 per cent of our total export trade in this product.

Pork exports have also decreased during the past three years. While the United Kingdom purchases a greater percentage of our hams and bacon than she does of our fresh pork, she takes more than half our exports of this product—continental Europe, the West Indies and Bermuda, and British America figuring rather prominently among the other purchasers.

Lard has also fallen in foreign demand. The United States sells the United Kingdom practically all the lard she imports, other countries also purchasing immense quantities. The United Kingdom takes about one-third the total amount, Germany following closely, and very large amounts go to other European countries.

The following table shows the total exports of hogs and hog products since and including the year 1790:

Total exports of hogs, hams and bacon, pork, and lard from the United States.[a]

Fiscal year.[b]	Live hogs.		Hams and bacon.		Pork.		Lard.	
	Number.	Value.	Pounds.	Value.	Barrels.	Value.	Pounds.	Value.
		Dollars.		*Dollars.*		*Dollars.*		*Dollars.*
1790	5,304	14,481	253,555	19,728	24,462	208,099	355,880	31,475
1791	16,803	45,368	295,647	26,590	[c]26,635	266,350	522,715	41,817
1792	21,291	----------	585,353	----------	[d]38,098	----------	515,245	----------
1793	9,901	----------	521,483	----------	38,563	----------	596,397	----------
1794	5,705	----------	1,147,262	----------	49,453	----------	1,100,780	----------
1795	4,922	----------	1,778,564	----------	88,193	----------	1,490,554	----------
1796	6,753	----------	2,096,877	----------	73,881	----------	1,124,971	----------
1797	3,484	----------	1,084,008	----------	40,125	----------	731,511	----------
1798	4,237	----------	1,105,584	----------	33,115	----------	876,773	----------
1799	3,786	----------	1,412,005	----------	52,268	----------	1,451,657	----------
1800	14,294	----------	1,173,244	----------	55,467	----------	1,633,562	----------
1801	7,312	----------	2,034,630	----------	70,779	----------	2,376,500	----------
1802	5,501	----------	1,588,267	----------	78,239	----------	1,958,400	----------
1803	6,859	----------	1,686,546	----------	96,602	----------	2,052,302	----------
1804	5,599	----------	1,904,284	----------	111,532	----------	2,565,719	----------
1805	2,808	----------	903,924	----------	57,925	----------	1,308,287	----------
1806	1,747	----------	1,347,018	----------	36,277	----------	1,542,500	----------
1807	1,831	----------	1,311,246	----------	39,274	----------	1,815,998	----------
1808	1,956	----------	258,418	----------	15,478	----------	585,173	----------
1809	537	----------	1,082,610	----------	42,652	----------	1,371,089	----------
1810	250	----------	1,218,855	----------	37,209	----------	1,365,333	----------
1811	4,454	----------	1,286,809	----------	37,270	----------	1,927,451	----------
1812	2,380	----------	729,398	----------	22,746	----------	1,616,417	----------
1813	485	----------	607,196	----------	17,337	----------	1,084,565	----------
1814	160	----------	138,556	----------	4,040	----------	513,928	----------
1815	757	----------	695,357	----------	9,073	----------	1,045,633	----------
1816	1,988	----------	530,129	----------	19,280	----------	1,088,348	----------
1817	1,103	5,515	341,419	61,455	14,462	303,702	926,018	166,683
1818	524	2,882	602,274	102,387	17,553	403,719	1,363,663	245,459
1819	2,324	13,944	700,369	105,055	28,173	563,460	2,178,076	326,711
1820	3,627	36,270	1,005,462	120,655	44,091	705,456	2,636,636	316,396
1821	7,885	----------	1,607,506	----------	66,647	----------	3,996,561	----------
1822	9,798	----------	1,142,945	----------	68,352	----------	4,137,814	----------
1823	11,436	----------	1,637,157	----------	55,529	----------	6,067,071	----------
1824	8,838	----------	1,409,199	----------	67,229	----------	5,053,182	----------
1825	4,525	----------	1,896,359	----------	85,709	----------	5,483,048	----------
1826	6,939	----------	1,836,133	----------	88,994	----------	7,231,643	----------
1827	18,441	----------	1,864,956	----------	73,813	----------	6,927,084	----------
1828	16,171	----------	1,837,920	----------	53,836	----------	7,493,319	----------
1829	10,779	----------	2,305,405	----------	59,539	----------	7,154,742	----------
1830	22,294	----------	2,154,986	----------	45,645	----------	6,001,417	----------
1831	14,690	----------	1,477,446	----------	51,263	----------	6,963,516	----------
1832	5,266	----------	1,810,830	----------	88,625	----------	7,756,782	----------
1833	6,819	----------	1,786,637	----------	105,870	----------	7,655,198	----------
1834	3,338	----------	1,520,638	----------	82,691	----------	9,050,342	----------
1835	3,930	----------	1,492,027	----------	61,827	----------	10,637,490	----------
1836	1,231	----------	1,398,475	----------	22,550	----------	6,493,878	----------

[a] Domestic and foreign exports were not separated until 1803; from this date the figures are for domestic exports only.

[b] The fiscal year ended September 30 up to and including 1842; thereafter June 30.

[c] Not including 29,334 pounds "fresh pork," valued at $1,760.

[d] Not including 3,008 pounds "fresh pork."

Total exports of hogs, hams and bacon, pork, and lard, etc.—Continued.

Fiscal year.	Live hogs.		Hams and bacon.		Pork.		Lard.	
	Number.	Value.	Pounds.	Value.	Barrels.	Value.	Pounds.	Value.
		Dollars.		*Dollars.*		*Dollars.*		*Dollars.*
1837	1,110	----------	965,935	----------	24,583	----------	6,388,174	----------
1838	366	----------	1,194,890	----------	31,356	----------	7,209,478	----------
1839	772	----------	1,445,527	----------	41,301	----------	7,723,834	----------
1840	4,854	----------	1,643,397	----------	66,281	----------	7,418,847	----------
1841	7,901	----------	2,794,517	----------	133,290	----------	10,597,654	----------
1842	5,564	----------	2,518,841	----------	180,032	----------	20,102,397	----------
1843 [a]	7,162	----------	2,422,067	----------	80,310	----------	24,534,217	----------
1844	9,615	----------	3,886,976	----------	161,629	----------	25,746,355	----------
1845	6,384	----------	2,719,369	----------	161,609	----------	20,060,993	----------
1846	7,437	----------	3,006,630	----------	190,422	----------	21,843,164	----------
1847	3,274	(b)	17,921,471	----------	206,190	----------	37,611,161	----------
1848	4,750	(b)	33,551,034	----------	218,259	----------	49,625,539	----------
1849	1,121	(b)	56,060,822	----------	253,485	----------	37,446,761	----------
1850	881	(b)	41,014,528	----------	188,841	----------	54,925,546	----------
1851	1,030	(b)	18,027,302	----------	165,201	----------	19,683,082	----------
1852	185	(b)	5,746,016	----------	83,382	----------	21,281,951	----------
1853	22	(b)	18,390,027	----------	129,881	----------	24,435,014	----------
1854	279	(b)	45,953,473	----------	220,147	----------	44,450,154	----------
1855	431	2,192	38,188,989	3,195,978	298,760	4,390,979	39,025,492	4,018,016
1856	1,391	6,331	41,748,092	3,863,328	281,395	5,029,940	37,582,271	3,870,949
1857	923	5,525	43,863,539	4,511,442	144,513	2,805,867	40,246,544	5,144,195
1858	96,000	810,406	20,954,374	1,957,423	159,874	2,852,942	33,022,286	3,809,501
1859	95,509	550,875	11,989,694	1,263,042	205,742	3,355,746	28,362,706	3,268,406
1860	48,355	377,664	25,844,610	2,273,768	204,743	3,132,313	40,289,519	4,545,831
1861	463	3,267	50,264,267	4,848,339	156,487	2,609,818	47,908,911	4,729,297
1862	3,306	23,562	141,212,786	10,290,572	309,102	3,980,153	118,573,307	10,004,521
1863	9,467	96,363	218,243,609	18,658,280	327,851	4,334,775	155,336,596	15,755,570
1864	9,199	86,907	110,886,446	12,323,327	315,597	5,828,030	97,190,765	11,260,728
1865	1,400	12,771	46,053,034	10,536,608	208,934	6,850,808	44,480,136	9,134,858
					Pounds.			
1866	951	15,454	37,588,930	6,269,796	30,056,788	4,788,484	30,110,451	5,970,651
1867	3,577	40,092	25,648,226	3,291,176	27,374,877	3,597,690	45,608,031	6,634,556
1868	1,399	18,447	43,659,064	5,476,998	28,690,133	3,267,652	64,555,462	9,427,831
1869	(b)	----------	49,228,165	7,482,060	24,439,832	3,422,928	41,887,545	7,443,948
1870	12,058	189,753	38,968,256	6,123,113	24,639,831	3,253,137	35,808,530	5,933,397
1871	8,770	61,390	71,446,854	8,126,683	39,250,750	4,302,320	80,037,297	10,563,020
1872	56,110	548,153	246,208,143	21,126,592	57,169,518	4,122,308	199,651,660	20,177,619
1873	99,720	787,402	395,381,737	35,022,137	64,147,461	5,007,035	230,534,207	21,245,815
1874	158,581	1,625,837	347,405,405	33,383,908	70,482,379	5,808,712	205,527,471	19,308,019
1875	64,979	739,215	250,286,549	28,612,613	56,152,331	5,671,495	166,869,393	22,900,522
1876	68,044	670,042	327,730,172	39,664,456	54,195,118	5,744,022	168,405,839	22,429,485
1877	65,107	699,180	460,057,140	49,512,412	69,671,894	6,296,414	234,741,233	25,562,665
1878	29,284	267,259	592,814,351	51,752,068	71,889,255	4,913,657	342,766,254	30,022,133
1879	75,129	700,262	732,249,576	51,074,433	84,401,676	4,807,568	326,658,686	22,856,673
1880	83,434	421,089	759,773,109	50,987,623	95,949,780	5,930,252	374,979,286	27,920,367
1881	77,456	572,138	746,944,545	61,161,205	107,928,086	8,272,285	378,142,496	35,226,575
1882	26,368	509,651	468,026,640	46,675,774	80,447,466	7,201,270	250,367,740	28,975,902
1883	16,129	272,516	340,258,670	38,155,952	62,116,302	6,192,268	224,718,474	26,618,048
1884	46,382	627,480	389,499,368	39,684,845	60,548,730	4,762,715	265,094,719	25,305.953
1885	55,025	579,183	400,127,119	37,083,948	72,073,468	5,203,943	283,216,339	22,595,219
1886	74,187	674,297	419,788,796	31,640,211	87,267,715	5,123,411	293,728,019	20,361,786

[a] For nine months only owing to change in fiscal year.

[b] None specified separately.

Total exports of hogs, hams and bacon, pork, and lard, etc.—Continued.

Fiscal year.	Live hogs.		Hams and bacon.		Pork.		Lard.	
	Number.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
		Dollars.		*Dollars.*		*Dollars.*		*Dollars.*
1887	75,383	564,753	419,922,955	33,314,670	85,893,297	5,641,327	321,533,746	22,703,921
1888	23,755	193,017	375,439,683	32,175,633	58,900,153	4,373,114	297,740,007	22,751,105
1889	45,128	356,764	400,224,646	34,651,847	64,133,639	4,735,077	318,242,990	27,329,173
1890	91,148	909,042	608,490,956	47,056,760	80,068,331	4,768,894	471,083,598	33,455,520
1891	95,654	1,146,630	599,085,665	45,650,674	82,136,239	4,843,701	498,343,927	34,414,323
1892	31,963	364,081	584,776,389	47,092,650	80,714,227	4,822,295	460,045,776	33,201,621
1893	27,375	397,162	473,936,329	45,714,566	53,372,366	4,196,263	365,693,501	34,643,993
1894	1,553	14,753	503,628,148	48,183,905	64,744,528	5,159,868	447,566,867	40,089,809
1895	7,130	72,424	558,044,099	48,736,860	59,085,474	4,199,060	474,895,274	36,821,508
1896	21,049	227,297	554,388,538	46,112,610	70,243,020	4,017,200	509,534,256	33,589,851
1897	28,751	295,998	665,646,750	50,157,168	68,075,344	3,392,030	568,315,640	29,126,485
1898	14,411	110,487	850,294,794	65,368,443	100,357,363	5,722,036	709,344,045	39,710,672
1899	33,031	227,241	788,498,230	62,331,151	178,507,564	10,639,727	711,259,851	42,208,465
1900	51,180	394,813	708,568,141	59,392,282	167,642,662	10,827,971	661,813,663	41,939,164
1901	22,318	238,465	672,694,544	60,341,804	178,317,791	13,059,551	611,357,514	46,530,148
1902	8,368	88,380	610,803,856	60,672,541	169,671,831	14,602,936	556,840,222	52,375,864
1903	4,031	40,923	421,519,365	47,891,158	116,253,487	11,995,253	490,755,821	50,854,504

Exports of lard oil and bristles, 1855 to 1903.

Fiscal year.	Lard oil.		Bristles.		Fiscal year.	Lard oil.		Bristles.	
	Gallons.	Value.	Pounds.	Value.		Gallons.	Value.	Pounds.	Value.
1855	103,200	$82,945			1880	1,507,596	$816,447	[b] 97,505	$22,742
1856	212,262	161,232			1881	836,255	558,576	29,707	8,722
1857	91,432	92,499			1882	506,259	434,124	32,965	10,005
1858	68,342	60,958			1883	379,205	353,184	33,047	10,053
1859	56,675	50,793			1884	712,696	504,218	73,287	20,852
1860	60,209	55,783			1885	916,157	555,426		
1861	85,676	81,783			1886	973,229	500,011		
1862	239,608	148,056			1887	975,163	519,274		
1863	1,259,063	983,349			1888	930,616	509,514		
1864	440,546	377,994			1889	861,303	542,897		
1865	100,520	157,671			1890	1,214,611	663,343		
1866	42,358	70,360			1891	1,092,448	562,986		
1867	144,158	176,363			1892	907,575	496,601		
1868	279,432	330,179			1893	486,812	336,613		
1869		97,370		$3,000	1894	681,081	449,571		1,844
1870	90,774	124,860		176	1895	553,421	304,093		
1871	147,802	153,850		275	1896	833,935	426,401		
1872	533,147	432,483			1897	961,407	419,803		
1873	388,836	298,731		3,150	1898	775,102	305,825		
1874	252,577	203,317		14,210	1899	917,007	412,447		
1875	146,594	147,384		640	1900	738,724	337,260		
1876	146,323	149,156		10,460	1901	766,783	438,645		
1877	347,305	281,551		22,770	1902	460,035	327,794		
1878	1,553,314	986,561	[a] 60,267	17,600	1903	356,658	306,334		
1879	1,963,208	1,037,923	80,140	22,350					

[a] Quantity from Baltimore only; the value includes $10 worth from other ports.
[b] Quantity from Baltimore only; the value includes $245 worth from other ports.

The foregoing tables show clearly the growth of our foreign trade in hogs and hog products. There is a tendency to abandon the export trade in live hogs. In the early years of the country's existence a larger number of live hogs were often shipped abroad in one year than during the fiscal year ended June 30, 1903, and the relative importance of these shipments—such, for example, as 5,304 in 1790, 14,294 in 1800, and 22,294 in 1830—undoubtedly represents a much greater proportion of the hog output in those years than 4,031 in 1903 or 51,180 in 1900. The least number exported was 22, in 1853, except one year, 1869, when live hogs were not specified separately. The greatest number exported was in 1874, when 158,581 hogs were sold abroad. Since 1870 there has been more uniformity in this branch of the trade than before that date. Except during 1871, 1894, 1895, 1902, and 1903, the number exported has never fallen below 12,000, and, except in 1874, it has never exceeded 100,000.

Hams and bacon were included in the same column in the early reports, and, for sake of uniformity, this method is adhered to in this table. From the earliest times hams and bacon have figured prominently in our export trade. From 1790 to 1846 there is not a specially marked tendency to growth, but rather a steady maintenance of trade. The foreign trade consumed from 1,000,000 to 2,000,000 pounds annually, occasionally going below and often exceeding these figures, dropping to 138,556 pounds in 1814, during the second war with Great Britain, when the foreign trade in all kinds of hog products was affected, and reaching 3,886,976 pounds in 1844. The real growth of our export trade in hams and bacon began with the fiscal year ended June 30, 1847. From slightly over 3,000,000 pounds in 1846 the foreign trade consumed nearly 18,000,000 pounds in 1847, and, except in 1852, when these products fell below 6,000,000 pounds, no year shows sales so small as 11,000,000 pounds. This rapid development characterizes the foreign demand for all hog products and has two very well-marked periods—the first from 1847 to 1871, the second from 1872 to the present time. During the first period exports of hams and bacon exceeded 100,000,000 pounds only during three years of the Civil War period. During the second period, when artificial refrigeration has played so important a part in the commerce in meats, the trade has shown a fairly constant growth, starting with 246,208,143 pounds, valued at $21,126,592, in 1872, and reaching 850,294,794 pounds, valued at $65,368,443, in 1898.

Pork shows a greater growth prior to 1847 than hams and bacon. There is the same period of depression due to the suspension of commerce during the war of 1812–1815, and after that time a very considerable foreign trade. From 1847 to 1871 growth was rapid, the same decrease being apparent in 1852 and the same increase in 1862 to 1864. After 1872 the lowest amount exported was 53,372,366 pounds, valued at $4,196,263, in 1893; the greatest amount was 178,507,564 pounds in 1899, valued at $10,639,727, and the greatest value was for 1902—169,671,831 pounds, valued at $14,602,936.

Prior to 1847 lard shows more growth than the other hog products. It was also least affected by the war of 1812–1815. In the year 1847 the same increase may be noticed and the same depression in the early fifties. There is also the same increase during the civil war. From 1871 to 1872 lard shows an increase of 150 per cent in the foreign trade, as compared with an increase of more than 240 per cent in that of hams and bacon and over 45 per cent in that of pork. From a foreign consumption of 199,651,660 pounds in 1872, valued at $20,177,619, the lard exports reached their maximum quantity in 1899, with 711,259,851 pounds, valued at $42,208,465, and their maximum value in 1902, with 556,840,222 pounds, valued at $52,375,864.

Lard oil does not figure in the exports until 1855, when 103,200 gallons, valued at $82,945, were exported. The rapid development of the early seventies is also seen in the exports of this product. The greatest amount was shipped in 1879—1,963,208 gallons, valued at $1,037,923, which was also the greatest value for any year.

Averages of five-year periods.—The following table shows the average annual exports of hog products from 1873 to 1902, inclusive, arranged in five-year periods:

Exports of hog products from the United States, average of five-year periods, 1873 to 1902.

Fiscal years.	Hams and bacon.		Pork.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*
1873–1877	356,172,201	37,239,105	62,929,837	5,705,536
1878–1882	659,961,644	52,330,221	88,123,253	6,225,006
1883–1887	393,919,382	35,975,925	73,579,902	5,384,733
1888–1892	513,603,468	41,325,513	73,190,518	4,708,616
1893–1897	551,128,773	47,781,022	63,104,148	4,192,884
1898–1902	726,171,913	61,621,244	158,899,442	10,970,444

Fiscal years.	Lard.		Lard oil.	
	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Gallons.*	*Dollars.*
1873–1877	201,215,629	22,289,301	256,327	216,028
1878–1882	334,582,892	29,000,330	1,273,326	766,726
1883–1887	277,658,259	23,516,985	791,290	486,423
1888–1892	409,091,260	30,230,348	1,001,311	555,068
1893–1897	473,201,108	34,854,329	703,331	387,296
1898–1902	650,123,059	44,558,863	731,530	364,394

These figures bring out much more clearly the rapid growth of our foreign trade. The annual amount of hams and bacon, pork, and lard oil exported have more than doubled since the five-year period of 1873–1877, while the lard exports have more than tripled in this time.

IMPORTS OF HOGS AND HOG PRODUCTS.

The following table shows the total imports of hogs and hog products into the United States since and including the year 1824:

Imports of hams and bacon, pork, and lard into the United States.

Fiscal year.[a]	Hams and bacon.[b]		Pork.[c]		Lard.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
1824	6,272	422	279	19		
1825	15,626	1,244	263,634	5,294		
1826	43,525	3,679	738,156	23,982		
1827	5,214	503	208,831	8,049	242	41
1828	3,894	343	461,143	22,094	1,648	88
1829	9,526	1,073	430,166	17,598	147	16
1830	7,617	681	659,099	23,220	135	10
1831	27,757	2,506	335,922	6,690	5,778	451
1832	24,305	2,204	90,837	2,115	723	41
1833	14,881	1,691	379,270	11,748	1,031	90
1834	29,950	3,189	1,196,009	37,102		
1835	65,625	5,739				
1836	173,945	16,244	75,311	4,226	210,073	27,631
1837	219,634	22,018	158,639	11,854	52,372	5,239
1838	215,268	20,959	990,768	26,570	80	9
1839	316,492	32,539	777,531	23,734	13,375	1,437
1840	122,481	14,087	467,916	12,432	98	7
1841	120,378	13,420	158,174	3,629	80	5
1842	59,384	6,232	186,973	3,154	40	3
1843[d]	26,815	2,731	359,801	5,984		
1844	26,499	3,222	259,379	6,312	47	3
1845	30,968	3,540	27,866	1,088		
1846	36,936	4,276	11,639	776	1,524	191
1847	21,356	2,880	29,364	1,908	350	17
1848	18,135	2,769	43,530	2,688	8,100	715
1849	23,188	2,268	25,184	1,515	249	14
1850	105,059	9,381	241,883	7,503	48	2
1851	136,273	13,456	41,276	1,667	2,672	131
1852	177,169	13,358	646,722	31,778	61,068	5,987
1853	81,149	7,455	748,300	26,766	16,130	946
1854	68,691	8,419	212,040	12,723	150,868	19,728
1855	75,216	9,411	158,397	6,194	104,068	9,329
1856	68,405	9,551	7,054	622	4,568	493
1857	48,263	7,204	36,323	2,614	362,931	28,046
1858	70,948	9,054	11,956	595	67,666	8,040
1859	85,623	12,197	12,348	1,340	12,165	1,378
1860	118,904	16,020	15,288	341	23,201	2,431
1861	77,639	11,055	2,548	151	199,754	9,627
1862	52,770	5,866			[e]271,529	21,239

[a] The fiscal year ended September 30, up to and including 1842; thereafter, June 30.
[b] From 1828 to 1842, inclusive, bacon only reported.
[c] Includes beef from 1824 to 1857 and from 1865 to 1871.
[d] For nine months only, owing to change of fiscal year.
[e] Includes tallow.

Imports of hams and bacon, pork, and lard into the United States—Continued.

Fiscal year.	Hams and bacon.		Pork.		Lard.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Pounds.	*Dollars.*	*Pounds.*	*Dollars.*	*Pounds.*	*Dollars.*
1863	51,421	7,357			[a] 250,343	20,213
1864					[a] 220,081	17,733
1865	122,573	13,020	12,252	927	272,111	33,117
1866	80,079	11,440	151,323	11,684	[b] 22,895	31,660
1867 [c]	116,520	15,046	[c] 745,496	46,924	9,800	1,163
1868	142,884	20,692	539,512	36,991	2,808	294
1869	151,281	23,369	426,659	29,897	6,018	1,030
1870	138,600	22,177	840,074	60,340	19,956	2,927
1871	144,150	23,504	997,257	70,291	9,565	1,478
1872	165,170	32,445	98,854	7,562	11,770	2,801
1873	118,852	21,828	90,214	5,722	3,050	548
1874	105,596	18,440	33,696	2,435	2,563	503
1875	96,254	17,577	19,649	1,717	1,882	268
1876	75,468	12,507	46,137	3,248	12,816	1,327
1877	73,774	14,193	42,428	3,112	12,524	1,167
1878	67,987	11,886	31,771	1,844	2,295	228
1879	56,305	9,774	31,181	1,476	1,500	170
1880	88,447	12,304	30,446	1,770	712	75
1881	77,423	14,341	28,647	2,026	1,655	225
1882	74,182	14,190	33,266	2,721	2,944	386
1883	107,810	21,181	50,651	4,509	1,387	200
1884	134,554	24,315	27,393	2,269	1,021	122
1885	139,158	23,893	45,165	2,975	561	62
1886	152,875	27,010	37,529	2,367	489	53
1887	191,378	32,537	28,831	1,591	782	83
1888	214,078	35,447	18,019	1,132	1,263	136
1889	272,130	45,900	13,719	978	1,073	88
1890	251,080	48,366	10,127	621	1,524	122
1891	211,332	39,892	11,267	808	1,795	187
1892	230,145	43,532	13,894	997	1,945	222
1893	247,784	47,540	12,822	1,054	6,051	510
1894	215,340	40,006	8,668	679	2,065	245
1895	265,264	45,716	12,245	835	2,015	210
1896	275,503	44,906	29,847	1,560	2,116	201
1897	253,683	40,346	9,660	543	1,423	139
1898	280,140	47,903	7,302	636	5,147	314
1899	265,245	45,833	16,628	1,585	1,766	181
1900	287,697	50,009	24,203	2,765	8,291	1,307
1901	285,942	50,505	11,663	1,116	3,084	290
1902	387,348	71,764	12,652	1,076	2,260	187
1903 [d]						

[a] Includes tallow.

[b] Quantity not given for Canada.

[c] From 1867 to 1902 the imports are for home consumption, prior to 1867 they are the total imports.

[d] Imports of meat products of hogs were not separately enumerated for this year.

The imports of bristles into the United States from 1816 to the present time are also presented here as affording opportunity for some interesting comparisons.

Imports of bristles, 1816 to 1903.

Fiscal year.[a]	Quantity.	Value.	Fiscal year.	Quantity.	Value.	Fiscal year.	Quantity.	Value.
	Pounds.	*Dollars.*		*Pounds.*	*Dollars.*		*Pounds.*	*Dollars.*
1816	4,731	-----	1846	445,725	244,719	1876	588,834	622,178
1817	88,809	-----	1847	420,682	191,473	1877	450,056	536,460
1818	99,810	-----	1848	485,661	175,025	1878	623,670	662,937
1819	144,726	-----	1849	221,045	88,265	1879	417,234	474,368
1820	-----	-----	1850	303,613	152,702	1880	984,285	1,009,495
1821	84,867	-----	1851	465,645	244,694	1881	838,840	911,519
1822	203,472	-----	1852	464,918	313,130	1882	862,072	1,032,355
1823	91,389	-----	1853	389,200	253,731	1883	1,020,999	1,228,543
1824	184,432	-----	1854	659,353	349,154	1884	988,736	1,201,735
1825	175,346	56,606	1855	507,847	315,113	1885	790,502	926,749
1826	121,852	49,069	1856	376,869	243,964	1886	1,076,330	1,087,137
1827	252,181	85,433	1857	470,845	289,581	1887	1,196,242	1,174,333
1828	404,847	132,242	1858	443,727	265,720	1888	1,114,214	1,215,325
1829	103,958	26,414	1859	329,083	222,179	1889	1,330,787	1,284,724
1830	115,551	26,518	1860	626,810	437,450	1890	1,261,609	1,286,219
1831	245,486	74,776	1861	569,311	396,871	1891	1,404,832	1,357,938
1832	410,206	110,722	1862	137,776	108,780	1892	1,495,003	1,455,058
1833	273,769	101,293	1863	271,851	218,279	1893	1,598,818	1,508,258
1834	146,514	69,337	1864	264,532	222,164	1894	892,520	929,231
1835	98,487	53,107	1865	266,827	220,004	1895	1,301,494	1,244,151
1836	362,169	216,034	1866	1,131,366	674,938	1896	1,572,530	1,435,348
1837	250,599	142,740	1867	831,422	689,390	1897	1,347,900	1,217,179
1838	115,190	30,413	1868	520,355	556,097	1898	1,535,090	1,249,119
1839	497,339	195,026	1869	-----	589,135	1899	1,856,577	1,458,252
1840	235,799	94,325	1870	-----	629,057	1900	2,530,158	2,152,867
1841	297,806	150,130	1871	-----	727,588	1901	1,684,575	1,730,197
1842	-----	74,395	1872	588,181	781,238	1902	2,013,109	2,047,331
1843[b]	26,695	8,271	1873	632,203	811,322	1903	3,043,865	2,654,604
1844	190,638	84,011	1874	522,006	645,102			
1845	343,218	172,076	1875	495,054	627,845			

[a] The fiscal year ended September 30, up to and including 1842; thereafter, June 30.
[b] For nine months only, owing to change in fiscal year.

The Treasury statistics do not give the importations of live hogs separately. The number imported during recent years is shown by the records of the Inspection Division of the Bureau of Animal Industry. Since the establishment of inspections November 15, 1890, these are as follows:

Imports of live hogs.

Fiscal year.	Canada.	Mexico.	Atlantic seaboard.	Total.
November 15, 1890, to June 30, 1891	29		70	99
1892	74		2	76
1893	16,008		24	16,032
1894	1,302		43	1,345
1895	908		23	931
1896	216	42	30	288
1897	212	12	55	279
1898	375	104	10	489
1899	196	64	47	307
1900	1,096	44	2	1,142
1901	443		74	[a]517
1902	5,370	64	12	5,453

[a] Including 7 hogs quarantined at San Francisco.

IMPORTS OF PORK PRODUCTS INTO THE UNITED KINGDOM.

The following table has been compiled from British trade reports to show the relative importance of American hog products on that market.[a] As the United Kingdom imports bacon to a greater extent than any other hog meat, and as the English figures show very striking comparisons between American bacon and that from other sources, this table has been arranged to show the British imports since 1888, the year that the bacon imports from Denmark, our strongest competitor, were first reported separately. The figures show total quantities, total values, and values per 100 pounds.

[a] In comparing the English import figures of pork products with the United States export statistics discrepancies will be noticed, especially in the commerce in bacon and pork ("fresh and salted"). As the accuracy of the figures are not to be questioned in either case, the following explanation from the reports of the British Board of Trade is interesting: "A considerable amount of Canadian produce finds its way to the United Kingdom via the ports of the United States in winter, when many Canadian ports are closed by ice. To a limited extent produce from the United States is sent to the United Kingdom via Canadian ports in the summer. Where, in such cases, the official documents enable a distinction to be drawn between Canadian and United States produce it is credited to the true country of origin. But in many cases such a distinction can not be made, so that in using the statistics it should be remembered that a certain amount of the trade of Canada with this country, especially in winter, is unavoidably included under the heading 'United States.'"—(Trade and Navigation of the United Kingdom, December, 1899, pp. II, III.)

Imports of pork products into the United Kingdom, 1888 to 1902.

[From Trade and Navigation, published by the British Government.]

Article and country.	1888. Quantity.	1888. Value.	1888. Value per 100 pounds.	1889. Quantity.	1889. Value.	1889. Value per 100 pounds.
	Pounds.	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Fresh pork:						
Holland	21,416,416	2,107,467	9.84	10,081,680	1,061,496	10.53
Belgium	3,913,168	399,691	10.21	1,672,048	183,102	10.95
United States	896	88	9.82	784	49	6.25
Other countries	1,860,656	203,172	10.92	1,332,240	147,849	11.10
Total	27,191,136	2,710,418	9.97	13,086,752	1,392,496	10.64
Bacon:						
Denmark	58,371,376	6,689,778	11.46	64,434,048	7,979,858	12.38
United States	208,894,560	18,750,435	8.98	285,336,016	23,410,094	8.20
Other countries[a]	52,442,096	5,671,122	10.81	42,022,064	4,073,241	9.69
Total	319,708,032	31,111,335	9.73	391,792,128	35,463,193	9.05
Hams:						
United States	72,427,264	8,257,823	11.40	97,810,048	10,789,454	11.03
Other countries	9,142,896	1,105,012	12.09	11,682,048	1,384,018	11.85
Total	81,570,160	9,362,835	11.48	109,492,096	12,173,472	11.12
Pork, salted (not bacon or hams):						
United States	16,746,800	1,156,441	6.91	21,477,904	1,376,324	6.41
Other countries	10,680,992	595,115	5.57	8,715,840	522,901	6.00
Total	27,427,792	1,751,556	6.39	30,193,744	1,899,225	6.29

Article and country.	1890. Quantity.	1890. Value.	1890. Value per 100 pounds.	1891. Quantity.	1891. Value.	1891. Value per 100 pounds.
	Pounds.	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Fresh pork:						
Holland	2,911,328	301,485	10.36	10,092,768	1,049,553	10.40
Belgium	1,219,456	133,328	10.93	3,508,064	367,606	10.48
United States	6,720	457	6.80	(b)	------------	----------
Other countries	935,536	99,238	10.61	681,184	56,052	8.23
Total	5,073,040	534,508	10.54	14,282,016	1,473,211	10.32
Bacon:						
Denmark	52,176,992	6,492,378	12.44	65,057,216	7,703,076	11.84
United States	328,660,080	23,802,013	7.24	299,606,048	21,985,217	7.34
Canada	(b)	------------	----------	16,924,208	1,382,646	8.17
Other countries[a]	43,706,768	3,664,343	8.38	11,555,936	1,292,864	11.19
Total	424,543,840	33,958,734	8.09	393,143,408	32,363,803	8.23
Hams:						
United States	122,570,896	12,573,795	10.26	125,041,392	12,558,359	10.04
Canada	------------	------------	----------	9,372,160	955,274	10.19
Other countries	12,887,056	1,388,753	10.78	524,384	70,895	13.52
Total	135,457,952	13,962,548	10.31	134,937.936	13,584,528	10.07
Pork, salted (not bacon or hams):						
United States	22,912,624	1,373,200	5.99	19,048,400	1,132,692	5.95
Other countries	5,631,360	288,340	5.12	6,352,976	307,461	4.84
Total	28,543,984	1,661,540	5.82	25,401,376	1.440,153	5.67

[a] In 1888 Germany exported to the United Kingdom 28,337,792 pounds of bacon, valued at $3.244.004, which is equivalent to $11.45 per 100 pounds. In 1889 the amount dropped to 7.127.568 pounds, and in 1890 to 155,680 pounds, and since that time small quantities have annually appeared until 1897, when they were dropped from the returns.

[b] Not separately enumerated.

Imports of pork products into the United Kingdom, 1888 to 1902—Continued.

Article and country.	1892.			1893.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	10,394,496	1,042,487	10.03	13,568,464	1,414,142	10.42
Belgium	2,522,464	271,249	10.75	2,826,096	308,643	10.92
Other countries	1,879,024	195,682	10.41	4,111,632	494,120	12.02
Total	14,795,984	1,509,418	10.20	20,506,192	2,216,905	10.81
Bacon:						
Denmark	75,250,784	9,340,746	12.41	79,727,648	10,453,914	13.11
United States	324,346,512	26,057,212	8.03	243,856,816	26,879,855	11.02
Canada	26,781,552	2,251,467	8.41	21,702,576	2,409,725	11.10
Other countries[a]	8,335,488	942,510	11.31	12,988,304	1,523,526	11.73
Total	434,714,336	38,591,935	8.88	358,275,344	41,267,020	11.52
Hams:						
United States	126,703,248	12,988,314	10.25	103,147,632	13,074,548	12.68
Canada	12,790,176	1,322,150	10.34	6,471,360	837,758	12.95
Other countries	857,360	112,440	13.11	1,083,040	153,105	14.14
Total	140,350,784	14,422,904	10.28	110,702,032	14,065,411	12.71
Pork, salted (not bacon or hams):						
United States	18,168,640	1,135,564	6.25	12,186,832	950,140	7.80
Other countries	7,407,008	354,860	4.79	8,748,320	459,086	5.25
Total	25,575,648	1,490,424	5.83	20,935,152	1,409,226	6.73

Article and country.	1894.			1895.		
	Quantity.	Value.	Value per 100 pounds.	Quantity.	Value.	Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	14,954,912	1,540,121	10.30	27,521,312	2,768,401	10.06
Belgium	3,425,520	374,896	10.94	3,040,800	327,418	10.77
Other countries	1,822,464	209,435	11.49	1,725,696	140,141	8.12
Total	20,202,896	2,124,452	10.52	32,287,808	3,235,960	10.02
Bacon:						
Denmark	85,884,736	10,655,640	12.41	113,560,160	12,189,108	10.73
United States	286,854,736	24,736,181	8.62	296,741,984	22,318,202	7.52
Canada	28,497,616	2,557,117	8.97	30,115,232	2,437,314	8.09
Other countries[a]	11,998,560	1,391,298	11.60	14,685,440	1,627,153	11.08
Total	413,235,648	39,340,236	9.52	455,102,816	38,571,777	8.48
Hams:						
United States	120,430,240	12,805,085	10.63	134,753,584	13,127,316	9.74
Canada	5,664,512	619,291	10.93	9,151,184	905,855	9.90
Other countries	441,056	64,724	14.68	521,248	70,034	13.44
Total	126,535,808	13,489,100	10.66	144,426,016	14,103,205	9.77
Pork, salted (not bacon or hams):						
United States	16,820,832	1,152,767	6.85	13,765,024	828,882	6.02
Other countries	8,381,296	480,216	5.73	10,893,792	484,241	4.45
Total	25,202,128	1,632,983	6.48	24,658,816	1,313,123	5.33

[a] See note [a], page 272.

Imports of pork products into the United Kingdom, 1888 to 1902—Continued.

Article and country.	1896. Quantity.	1896. Value.	1896. Value per 100 pounds.	1897. Quantity.	1897. Value.	1897. Value per 100 pounds.
	Pounds.	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Fresh pork:						
Holland	27,366,528	2,708,339	9.90	25,336,080	2,378,526	9.39
Belgium	4,391,296	478,572	10.90	4,125,184	450,492	10.92
United States						
Other countries	1,776,208	157,548	8.87	9,471,840	894,477	9.34
Total	33,534,032	3,344,459	9.97	38,933,104	3,723,495	9.56
Bacon:						
Denmark	136,876,768	13,586,266	9.93	114,973,824	13,355,769	11.62
United States	308,170,016	19,790,634	6.42	402,375,120	26,053,411	6.47
Canada	51,152,976	3,385,347	6.62	32,511,696	2,546,128	7.83
Other countries[a]	13,347,152	1,461,751	10.95	10,689,846	1,200,064	11.23
Total	509,546,912	38,223,998	7.50	560,550,486	43,155,372	7.70
Hams:						
United States	144,029,312	13,424,114	9.32	179,595,696	16,602,352	9.24
Canada	18,958,912	1,778,326	9.38	13,342,896	1,266,614	9.49
Other countries	465,920	59,337	12.74	359,408	49,322	13.72
Total	163,454,144	15,261,777	9.34	193,298,000	17,918,288	9.27
Pork, salted (not bacon or hams):						
United States	15,419,376	856,888	5.56	15,839,936	815,139	5.15
Other countries	13,178,592	563,964	4.28	10,727,136	419,458	3.91
Total	28,597,968	1,420,852	4.97	26,567,072	1,234,597	4.65

Article and country.	1898. Quantity.	1898. Value.	1898. Value per 100 pounds.	1899. Quantity.	1899. Value.	1899. Value per 100 pounds.
	Pounds.	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Fresh pork:						
Holland	24,939,264	2,308,969	9.26	38,566,752	3,541,045	9.18
Belgium	3,931,424	429,508	10.92	3,958,304	447,699	11.31
United States				31,006,528	2,692,907	8.68
Other countries	33,580,736	2,932,845	8.73	1,393,280	146,248	10.50
Total	62,451,424	5,671,322	9.08	74,924,864	6,827,899	9.11
Bacon:						
Denmark	113,962,240	13,144,962	11.53	135,588,544	14,335,526	10.57
United States	457,787,568	31,331,690	6.84	457,917,152	31,886,184	6.96
Canada	60,018,448	4,845,209	8.07	50,822,576	3,707,597	7.30
Other countries[a]	7,899,808	908,566	11.50	5,785,024	685,223	11.84
Total	639,668,064	50,230,427	7.85	650,113,296	50,614,530	7.79
Hams:						
United States	207,370,240	17,769,606	8.57	204,284,080	18,400,271	9.01
Canada	13,151,936	1,135,218	8.63	16,878,176	1,465,848	8.68
Other countries	375,312	49,410	13.17	443,856	59,765	13.46
Total	220,897,488	18,954,234	8.58	221,606,112	19,925,884	8.99
Pork, salted (not bacon or hams):						
United States	19,600,000	1,092,695	5.57	18,372,704	972,570	5.30
Other countries	11,311,216	463,505	4.10	13,515,936	515,747	3.82
Total	30,911,216	1,556,200	5.03	31,888,640	1,488,317	4.67

[a] See note [a], p. 272.

Imports of pork products into the United Kingdom, 1888 to 1902—Continued.

Article and country.	1900. Quantity.	1900. Value.	1900. Value per 100 pounds.	1901. Quantity.	1901. Value.	1901. Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
Holland	43,588,608	4,009,149	9.20	42,230,832	3,896,748	9.23
Belgium	5,771,024	618,084	10.71	4,533,984	477,511	10.53
United States	26,676,048	2,445,991	9.17	39,080,720	3,713,105	9.50
Other countries	1,848,560	204,106	11.04	2,803,472	261,764	9.34
Total	77,884,240	7,277,330	9.34	88,649,008	8,349,128	9.42
Bacon:						
Denmark	122,598,112	14,885,563	12.14	118,821,808	15,740,480	13.25
United States	443,131,024	36,459,541	8.23	475,364,848	45,043,599	9.48
Canada	59,344,768	5,233,653	8.82	44,654,064	4,484,524	10.04
Other countries[a]	6,744,752	719,264	10.66	7,662,256	867,989	11.33
Total	631,818,656	57,298,021	9.07	646,502,976	66,136,592	10.23
Hams:						
United States	179,474,736	18,311,248	10.20	193,820,032	20,487,070	10.57
Canada	21,972,384	2,175,043	9.90	14,097,104	1,483,416	10.52
Other countries	451,920	59,143	13.09	477,904	66,914	14.00
Total	201,899,040	20,545,434	10.18	208,395,040	22,037,400	10.57
Pork, salted (not bacon or hams):						
United States	14,381,024	864,636	6.01	15,420,160	1,011,531	6.56
Other countries	13,476,512	601,879	4.47	12,249,440	566,032	4.62
Total	27,857,536	1,466,515	5.26	27,669,600	1,577,563	5.70

Article and country.	1902. Quantity.	1902. Value.	1902. Value per 100 pounds.
Fresh pork:	*Pounds.*	*Dollars.*	*Dollars.*
Holland	39,580,576	3,660,041	9.25
Belgium	3,881,472	407,433	10.50
United States	28,271,152	2,785,234	9.85
Other countries	1,668,912	184,956	11.08
Total	73,402,112	7,037,664	9.59
Bacon:			
Denmark	140,630,224	18,245,034	12.97
United States	367,791,760	40,097,634	10.90
Canada	51,798,544	5,855,762	11.30
Other countries[a]	9,826,320	1,143,905	11.64
Total	570,046,848	65,342,335	11.46
Hams:			
United States	147,031,248	16,653,182	11.33
Canada	18,360,160	2,045,482	11.14
Other countries	624,736	81,168	12.99
Total	166,016,144	18,779,832	11.31
Pork, salted (not bacon or hams):			
United States	11,807,264	910,688	7.71
Other countries	11,182,416	576,452	5.15
Total	22,989,680	1,487,140	6.47

[a] See note [a], p. 272.

Referring to the imports for the year ended December 31, 1902, we see that of the total imports into the United Kingdom of meat products of hogs there were imported 73,402,112 pounds of fresh pork, or 8.82 per cent of the total amount, valued at $7,037,664, or $9.59 per 100 pounds; 570,046,848 pounds of bacon, 68.61 per cent of the total amount, valued at $65,342,335, or $11.46 per 100 pounds; 166,016,144 pounds of hams, which were 19.94 per cent of the total, and valued at $18,779,832, or $11.31 per 100 pounds, and 22,989,680 pounds of salted pork (not bacon or hams), which were 2.63 per cent of the total amount of meat products of hogs imported, and were valued at $1,487,140, an average value per 100 pounds of $6.47.

Except for very small amounts, fresh pork from the United States was first reported separately in 1899, when 31,006,528 pounds, valued at $2,692,907, were imported. The bulk of this product now reaches the United Kingdom from Holland and the United States, Holland furnishing a somewhat larger amount, which generally, although not always, sells for slightly more than the fresh pork from America. In quality the Belgian fresh pork is ranked higher than that from either Holland or the United States, but the imports from that source do not form a very large proportion of the total of the fresh pork imported in 1902. Holland furnished 39,580,576 pounds, or 53.92 per cent, valued at $3,660,041, and the United States furnished 28,271,152 pounds, or 38.52 per cent of the total amount, and valued at $2,785,234; Belgium furnished 3,881,472 pounds, or 5.29 per cent, valued at $407,433. The value per 100 pounds of the pork from Belgium was $10.50, that from Holland $9.25, and that from the United States $9.85.

The United States is easily the principal source of hams that are imported into the United Kingdom. Until 1891 this country was the only one whose imports were separately enumerated. For that year Canada is reported with 9,372,160 pounds, valued at $955,274, which is $10.19 per 100 pounds. Until 1899 the Canadian hams had a greater value per 100 pounds than those of the United States, since which date the hams from the United States have had the greater value per 100 pounds. There were imported in 1902, 166,016,144 pounds of hams, of which the United States furnished 147,031,248 pounds, or 88.56 per cent; Canada furnished 18,360,160 pounds, or 11.06 per cent.

Although there has not been a marked tendency toward decreased importations of salted pork (not bacon or hams) from the United States, other countries not enumerated are gradually selling the United Kingdom a larger proportion of this product. In 1902 there were credited to the United States 11,807,264 pounds, or 51.37 per cent of the total amount imported, valued at $910,688. The value per 100 pounds of the United States product in 1902 was $7.71, which is $1.24 above the average value per 100 pounds of all imported.

Attention is now called to the imports of bacon into the United

Kingdom. As is well known, the English people consume large quantities of bacon, and are generally regarded as being accurate judges of this product, the English market being the most critical in the world for bacon. While the highest prices are supposed to be obtained by the native Wiltshire and the Irish bacon, great quantities are imported, bacon comprising 68.61 per cent of the total imports of meat products of hogs in 1902. In the year ended December 31, 1902, the United States supplied 367,791,760 pounds of the total amount of bacon imported, which had a total value of $40,097,634 and an average value per 100 pounds of $10.90. This was 64.52 per cent of the total amount and 61.36 per cent of the total value of bacon imported. From Denmark 140,630,224 pounds were imported—24.67 per cent of the total amount—with a valuation of $18,245,034, 27.92 per cent of the total value, and an average value per 100 pounds of $12.97. Canada is credited with 51,798,544 pounds—9.09 per cent of the total amount—valued at $5,855,762, or 8.97 per cent of the total value, and an average value per 100 pounds of $11.30. A more careful examination of the table shows that never since Danish or Canadian bacon have been separately reported in the British customs reports have the prices per 100 pounds for bacon from the United States been equal to that of the bacon from these countries, the difference between United States bacon and Danish bacon being particularly striking in this respect. This discrimination against the bacon from this country is not a new subject for discussion. In his report for 1894 the Secretary of Agriculture called particular attention to the need of careful study by the producers in the United States if they wished to supply this market with a product that is really desirable according to the English standards, and the subject has often been referred to in the press.

During the fifteen years for which we have figures regarding Danish bacon the valuation per 100 pounds has been less than $11 in three years only (1895, 1896, and 1899), and in one year only (1896) has it fallen below $10, when a valuation of $9.93 was reached. In the years 1893 and 1901 it was more than $13. On the other hand, in the years 1893, 1901, and 1902 only has bacon from the United States had a valuation of more than $9 per 100 pounds, and in the years 1893 and 1902 only, when extremely high prices were recorded in this country for live hogs, has the valuation been in the neighborhood of $11 per 100 pounds, being $11.02 and $10.90, respectively, in these years. In no year has it sold up to the average valuation per 100 pounds of the total imports of bacon into the United Kingdom. In three years—1888, 1893, and 1902, all years of high prices in this country—the difference in value per 100 pounds between Danish and United States bacon has been less than $2.50, as follows: 1888, $2.48; 1893, $2.09; 1902, $2.07. In 1895 the difference was less than $3.50, but in all other years it was more than $3.50, a difference of more than $4 being noticed in the years 1889, 1890, 1891, 1892, 1897, and

1898, and a difference of over $5 in the years 1890 and 1897. The greatest difference was in 1890, when the Danish bacon averaged $5.20 per 100 pounds more than that from this country. The average valuation per 100 pounds of all bacon imported into the United Kingdom for the entire period from 1888 to 1902 was $8.94; that of the United States bacon was $8.07, and that of the Danish bacon, $11.83, a difference of $3.76 in favor of the Danish bacon.

A further evidence of the fact that Danish bacon stands higher in the esteem of the English people than that produced in the United States is that there is less fluctuation in its value in periods of greatest supply. If we take the periods immediately preceding the years 1893 and 1902, when the prices of hogs reached extreme points in the United States, and exports from this country diminished very noticeably, we find a range in value per 100 pounds in the Danish bacon from $11.46 to $12.44 during the years 1888 to 1892, a fluctuation of $0.98, and during the years 1894 to 1901, a range from $9.93 to $13.25, a difference of $3.32. The values reached during the years 1893 and 1902, immediately following the above periods, were $13.11 and $12.97, respectively, the year 1902 showing a slight decrease in the value of the Danish product. The extreme range including the year of highest value is $1.65 during the years from 1888 to 1893. The extreme range during the later period is $3.32, and is shown by the returns for the years 1896 and 1901. During these two periods the United States bacon ranged in valuation from $7.24 to $8.98 in the years 1888 to 1892 and reached a valuation per 100 pounds of $11.02 in 1893, showing a fluctuation in normal years of $1.74 and an extreme fluctuation of $3.78. During the years 1894 to 1901 the range is from $6.42 in 1896 to $9.48 in 1901, the extreme of $10.90 being reached in 1902, thus showing a fluctuation in normal years of $3.06, and an extreme fluctuation, including the year of scarcity of supply and high prices, of $4.48.

These figures would seem to indicate that the Danish bacon is a finer product than the United States bacon; that a more constant demand exists for it on the English market, and that it supplies a finer trade than bacon from the United States. It is evident that the English people buy American bacon because it is in abundance and cheap in price, and they only pay well for it when forced to do so by scarcity and high prices in the country of production.

A somewhat surprising feature that is shown by these figures is the rating of bacon from Canada, which, while it shows a higher rating on the English market than the United States bacon, does not greatly exceed the average valuation from year to year, and seems to be affected by conditions similar to those that govern the valuations of the bacon from the United States. During the years 1888–1902 the average valuation of the Canadian bacon imported into the United Kingdom was $8.96—2 cents per 100 pounds more than the average and 89 cents more than the United States bacon, but $2.87 less than that from Denmark.

MISCELLANEOUS TRADE STATISTICS.

Having devoted attention to the total production and foreign trade of hogs and hog products, it is of much interest to study the figures showing the stocks in the country after the foreign demand and the local consumption have been supplied. The total production, less the sum of the foreign consumption during a given period, and the stocks on hand at the close of the period will represent quite accurately the home consumption for that period. The following table gives a comparison of the aggregate stocks of hog meats (including pork) and lard in the West, in the East, and in transit on March 1 for the years of 1881 to 1903, inclusive:

Comparison of the aggregate of meats (including pork) and lard in the West, in the East, and in transit on March 1, 1881 to 1903.

[Cincinnati Price Current.]

Year.	Meats and pork.	Lard.	Total product.	Year.	Meats and pork.	Lard.	Total product.
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*	*Pounds.*
1881	414,000,000	86,000,000	500,000,000	1893	299,000,000	22,000,000	321,000,000
1882	406,000,000	106,000,000	512,000,000	1894	336,000,000	24,000,000	360,000,000
1883	445,000,000	88,000,000	533,000,000	1895	555,000,000	48,000,000	603,000,000
1884	329,000,000	81,000,000	410,000,000	1896	476,000,000	74,000,000	550,000,000
1885	427,000,000	76,000,000	503,000,000	1897	510,000,000	134,000,000	644,000,000
1886	453,000,000	99,000,000	552,000,000	1898	591,000,000	94,000,000	685,000,000
1887	396,000,000	78,000,000	474,000,000	1899	696,000,000	97,000,000	793,000,000
1888	408,000,000	61,000,000	469,000,000	1900	511,000,000	72,000,000	583,000,000
1889	380,000,000	42,000,000	422,000,000	1901	519,000,000	41,000,000	560,000,000
1890	426,000,000	53,000,000	479,000,000	1902	565,000,000	52,000,000	617,000,000
1891	686,000,000	113,000,000	799,000,000	1903	446,000,000	29,000,000	475,000,000
1892	611,000,000	80,000,000	691,000,000				

APPARENT DOMESTIC CONSUMPTION OF MEAT PRODUCTS OF HOGS.

The following table is an estimate of the apparent annual domestic consumption of the meat products of hogs, including barreled pork, also the monthly average, for 1890 to 1903:

Apparent domestic consumption of meat products of hogs (including barreled pork) from 1891 to 1903.

[Cincinnati Price Current.]

SUMMER SEASON—MARCH 1 TO NOVEMBER 1.

Year.	Total.	Monthly average.
	Pounds.	*Pounds.*
1902	1,767,000,000	221,000,000
1901	1,809,000,000	226,000,000
1900	1,802,000,000	225,000,000
1899	1,857,000,000	232,000,000
1898	1,756,000,000	219,000,000
1897	1,578,000,000	197,000,000
1896	1,468,000,000	183,000,000
1895	1,327,000,000	166,000,000
1894	1,222,000,000	153,000,000
1893	1,060,000,000	132,000,000
1892	1,429,000,000	179,000,000
1891	1,346,000,000	168,000,000

Apparent domestic consumption of meat products of hogs, etc.—Continued.

WINTER SEASON—NOVEMBER 1 TO MARCH 1.

Year.	Total.	Monthly average.
	Pounds.	*Pounds.*
1902-03	797,000,000	199,000,000
1901-02	807,000,000	202,000,000
1900-01	864,000,000	216,000,000
1899-00	842,000,000	210,000,000
1898-99	787,000,000	197,000,000
1897-98	730,000,000	182,000,000
1896-97	652,000,000	163,000,000
1895-96	623,000,000	156,000,000
1894-95	603,000,000	151,000,000
1893-94	504,000,000	126,000,000
1892-93	513,000,000	128,000,000
1891-92	807,000,000	202,000,000

TWELVE MONTHS ENDED MARCH 1.

1902-03	2,564,000,000	213,000,000
1901-02	2,630,000,000	219,000,000
1900-01	2,666,000,000	222,000,000
1899-00	2,699,000,000	225,000,000
1898-99	2,543,000,000	212,000,000
1897-98	2,308,000,000	192,000,000
1896-97	2,120,000,000	177,000,000
1895-96	1,950,000,000	162,000,000
1894-95	1,825,000,000	152,000,000
1893-94	1,564,000,000	130,000,000
1892-93	1,942,000,000	162,000,000
1891-92	2,153,000,000	179,000,000

DOMESTIC AND EXPORT CONSUMPTION OF LARD.

The following table shows the estimated domestic and export consumption of lard from 1892–93 to 1902–03:

Domestic and export consumption of lard, 1892–93 to 1902–03.

[Cincinnati Price Current.]

Year.	Domestic.	Export.	Total.	Year.	Domestic.	Export.	Total.
	Tierces.	*Tierces.*	*Tierces.*		*Tierces.*	*Tierces.*	*Tierces.*
1902-03	795,000	1,594,000	2,389,000	1896-97	658,000	1,600,000	2,258,000
1901-02	1,077,000	1,700,000	2,777,000	1895-96	390,000	1,503,000	1,893,000
1900-01	1,091,000	1,857,000	2,948,000	1894-95	496,000	1,470,000	1,966,000
1899-00	870,000	2,067,000	2,937,000	1893-94	495,000	1,130,000	1,625,000
1898-99	673,000	2,230,000	2,903,000	1892-93	423,000	1,306,000	1,729,000
1897-98	768,000	1,990,000	2,758,000				

COMPARATIVE MONTHLY AND YEARLY PRICES OF HOGS.

Highest monthly and yearly prices of hogs at Chicago per 100 pounds from 1881 to 1902.

[Cincinnati Price Current.]

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
1902	$6.85	$6.55	$7.00	$7.50	$7.50	$7.95	$8.25	$7.95	$8.20	$7.92	$6.95	$6.90	$8.25
1901	5.47	5.65	6.20	6.25	6.00	6.30	6.40	6.70	7.40	7.10	6.30	6.70	7.40
1900	4.92	5.10	5.55	5.85	5.57	5.42	5.55	5.57	5.70	5.55	5.12	5.10	5.85
1899	4.05	4.05	4.00	4.15	4.05	4.00	4.70	5.00	4.90	4.90	4.35	4.45	5.00
1898	4.00	4.27	4.17	4.15	4.80	4.50	4.17	4.20	4.15	4.00	3.85	3.75	4.80
1897	3.60	3.75	4.25	4.25	4.05	3.65	4.00	4.55	4.65	4.40	3.80	3.60	4.65
1896	4.45	4.35	4.25	4.15	3.75	3.60	3.70	3.70	3.50	3.65	3.70	3.60	4.45
1895	4.80	4.65	5.30	5.42	4.97	5.10	5.70	5.40	4.65	4.50	3.85	3.75	5.70
1894	5.65	5.50	5.25	5.60	5.35	5.20	6.00	6.15	6.75	6.15	5.05	4.90	6.75
1893	8.40	8.75	8.55	7.90	8.00	7.45	6.45	6.30	7.05	7.00	6.50	6.60	8.75
1892	4.75	5.05	5.10	5.00	5.10	5.75	6.10	6.20	5.70	5.97	6.07	7.00	7.00
1891	3.85	3.80	5.15	5.50	5.15	4.85	5.85	5.90	5.75	5.50	4.40	4.15	5.90
1890	4.00	4.15	4.45	4.50	4.35	4.05	4.05	4.40	4.95	4.80	4.35	3.90	4.95
1889	5.35	5.05	5.10	5.05	4.85	4.65	4.80	4.80	4.85	4.85	4.25	3.85	5.35
1888	6.00	5.80	5.95	5.90	5.90	5.90	6.75	6.75	6.90	6.90	6.80	5.50	6.90
1887	5.15	5.95	6.10	5.95	5.55	5.35	5.75	5.55	5.60	4.90	5.50	5.90	6.10
1886	4.40	4.65	4.65	4.55	4.40	4.70	5.25	5.25	5.20	4.80	4.20	5.00	5.25
1885	5.05	5.35	5.05	4.85	4.55	4.35	5.30	5.35	4.80	4.35	4.00	4.10	5.35
1884	6.75	7.75	7.60	7.10	6.20	5.90	5.85	6.90	6.90	5.90	5.05	4.60	7.75
1883	7.10	7.65	8.10	8.15	7.90	7.25	6.60	6.50	6.00	5.40	5.50	6.15	8.15
1882	7.35	7.50	7.65	7.80	8.60	8.75	9.00	9.50	9.30	9.25	7.75	7.00	9.50
1881	5.90	6.75	6.75	6.65	6.60	6.35	7.10	7.00	7.50	7.40	6.90	6.65	7.50

PRICES OF HOG PRODUCTS.

Prices of mess pork, D. S. short-rib sides, S. P. hams, and S. P. shoulders at Chicago, March 1, 1881, to 1903.

[Cincinnati Price Current.]

Year.	Mess pork.	Lard.	S. R. sides.	Hams.	Shoulders.
	Per barrel.	*100 pounds.*	*100 pounds.*	*100 pounds.*	*100 pounds.*
1903	$18.25	$9.70	$9.75	$10.80	$8.55
1902	13.25	8.95	8.25	9.40	7.00
1901	13.90	7.35	7.00	8.75	6.50
1900	10.50	5.75	5.75	9.25	6.50
1899	9.25	5.25	4.65	7.00	4.50
1898	10.35	5.10	5.00	7.15	5.00
1897	8.00	4.00	4.20	8.50	4.75
1896	9.75	5.35	5.05	8.00	5.25
1895	10.20	6.40	5.15	8.25	5.15
1894	11.85	7.05	6.10	9.00	6.90
1893	18.25	12.70	10.20	13.50	10.00
1892	11.15	6.42½	5.82½	8.40	5.00
1891	9.65	5.65	4.67½	6.85	3.45
1890	9.80	5.85	4.80	8.40	4.50
1889	11.15	6.70	5.90	9.00	5.50
1888	13.90	7.70	7.15	9.50	6.12½
1887	18.25	7.05	7.65	11.00	7.00
1886	10.45	5.85	5.30	8.00	4.37½
1885	12.40	6.80	6.10	8.62½	5.37½
1884	17.80	9.40	9.25	12.25	7.75
1883	18.20	11.42½	9.85	11.00	8.00
1882	17.00	10.40	9.00	10.25	6.75
1881	14.37½	10.00	7.32½	8.50	5.50

For 1887 the price of mess pork on March 1 was influenced fully $3.50 per barrel by manipulation.

CHICAGO PORK AND LARD PRICES.

Lowest, highest, and average yearly prices at Chicago for mess pork per barrel and lard per hundred pounds, 1870 to 1902.

[Cincinnati Price Current.]

Year.	Pork.			Lard.		
	Low.	High.	Average.	Low.	High.	Average.
1870	$18.00	$30.50	$26.25	$11.00	$17.25	$15.00
1871	12.00	23.00	15.90	8.37	13.00	10.25
1872	11.05	16.00	13.10	7.00	11.00	8.50
1873	11.00	18.00	14.80	6.50	9.37	7.90
1874	13.75	24.75	18.35	8.20	15.50	11.50
1875	17.70	23.50	20.20	11.80	15.75	13.50
1876	15.20	22.75	18.65	9.55	13.85	11.25
1877	11.40	17.95	14.05	7.55	11.55	9.10
1878	6.05	11.45	8.80	5.32	7.80	6.67
1879	7.30	13.75	9.85	5.32	7.85	6.22
1880	9.40	19.00	13.15	6.35	8.75	7.37
1881	12.50	20.00	16.55	8.37	13.00	10.90
1882	16.00	24.75	19.30	10.05	13.10	11.45
1883	10.20	20.15	15.30	7.15	12.10	9.65
1884	10.55	19.50	16.05	6.45	10.00	7.95
1885	8.00	13.25	10.40	5.82	7.10	6.47
1886	8.20	12.35	9.80	5.82	7.50	6.22
1887	11.60	24.00	15.95	6.20	7.92	6.75
1888	12.90	16.00	14.10	7.25	11.20	8.42
1889	8.35	13.37	11.00	5.75	7.55	6.50
1890	7.50	13.62	10.60	5.50	6.52	6.00
1891	7.45	13.00	10.25	5.47	7.05	6.25
1892	9.35	15.05	11.35	6.05	10.60	6.95
1893	10.25	21.80	17.30	6.37	13.20	9.85
1894	10.67	14.57	12.50	6.45	9.05	7.35
1895	7.50	12.87	10.25	5.15	7.17	6.25
1896	5.50	10.85	7.50	3.05	5.85	4.35
1897	7.15	9.00	8.00	3.42	4.90	4.15
1898	7.65	12.30	9.45	4.62	6.82	5.25
1899	7.85	10.45	8.70	4.90	5.77	5.25
1900	10.35	16.00	11.70	5.65	7.40	6.65
1901	12.60	16.80	14.60	6.90	10.25	8.60
1902	15.00	18.70	16.25	9.07	11.60	10.25

RELATIVE COST OF HOG PRODUCTS.

The following figures and comments by the Cincinnati Price Current form an interesting and instructive study of the relation between the cost of hogs on the hoof and the dressed product:

It is impracticable to compile a table indicating the relative value of leading articles of hog products on the basis of cost of hogs which would be a permanent guide in these particulars, owing to the changes frequently occurring in the relation of these values, as well as some variation in the proportions of product made. On March 1, 1903, Chicago prices were about $9.60 per 100 pounds for green sides, $8.30 for green shoulders, $10.65 for green hams, and $9.70 for lard in tierces. On this basis, calculating sides at 36 per cent, shoulders 10 per cent, hams 11 per cent, and lard 14 per cent of live weight of hogs, and that the remainder of the product, or offal, covers the cost of manufacture, these values represent $6.76 per 100 pounds for hogs alive, and relatively for the various prices stated for hogs, as shown in

the following compilation, * * * indicating cost of green sides, shoulders, and hams, lard in tierces per 100 pounds, and mess pork per barrel:

Relation between prices per 100 pounds of live hogs and of the dressed products.

Hogs, alive.	Sides, green.	Shoulders, green.	Hams, green.	Lard, in tierces.	Pork, in barrels.
$3.00	$4.25	$3.68	$4.72	$4.48	$8.74
3.25	4.60	3.99	5.11	4.83	9.39
3.50	4.96	4.30	5.50	5.38	10.04
3.75	5.31	4.61	5.89	5.53	10.69
4.00	5.67	4.91	6.29	5.88	11.34
4.25	6.02	5.22	6.68	6.23	11.99
4.50	6.38	5.52	7.08	6.57	12.64
4.75	6.73	5.83	7.47	6.92	13.29
5.00	7.09	6.13	7.87	7.26	13.93
5.25	7.44	6.44	7.26	7.61	14.58
5.50	7.80	6.75	7.65	7.95	15.23
5.75	8.15	7.06	8.04	8.30	15.88
6.00	8.51	7.36	9.44	8.64	16.52
6.25	8.86	7.67	9.83	8.99	17.17
6.50	9.22	7.98	10.22	9.33	17.82
6.75	9.57	8.29	10.61	9.78	18.47
7.00	9.93	8.59	11.01	10.02	19.11
7.25	10.28	8.90	11.40	10.37	19.76
7.50	10.64	9.21	11.80	10.72	20.41
7.75	10.99	9.51	12.19	11.06	21.06
8.00	11.35	9.82	12.59	11.41	21.70
8.25	11.70	10.13	12.98	11.75	22.35
8.50	12.05	10.44	13.37	12.10	23.00

In order to indicate the relative value of hogs at a stated price for mess pork and green sides, on the basis of values in Chicago on March 1, 1903, as mentioned, the following is submitted:

Relative value per 100 pounds of dressed product and live hogs.

Pork.	Hogs.	Pork.	Hogs.	Pork.	Hogs.
$7.00	$2.32	$11.50	$4.05	$16.00	$5.80
7.50	2.51	12.00	4.25	16.50	5.79
8.00	2.70	12.50	4.44	17.00	6.18
8.50	2.89	13.00	4.64	17.50	6.37
9.00	3.09	13.50	4.83	18.00	6.57
9.50	3.28	14.00	5.02	18.50	6.76
10.00	3.48	14.50	5.21	19.00	6.96
10.50	3.67	15.00	5.41	19.50	7.15
11.00	3.86	15.50	5.60	20.00	7.34
Sides.	**Hogs.**	**Sides.**	**Hogs.**	**Sides.**	**Hogs.**
$3.50	$2.47	$5.75	$4.05	$8.00	$5.64
3.75	2.65	6.00	4.23	8.25	5.82
4.00	2.82	6.25	4.40	8.50	6.00
4.25	3.00	6.50	4.58	8.75	6.17
4.50	3.17	6.75	4.75	9.00	6.34
4.75	3.35	7.00	4.93	9.25	6.51
5.00	3.52	7.25	5.10	9.50	6.69
5.25	3.70	7.50	5.28	9.75	6.87
5.50	3.87	7.75	5.46	10.00	7.05

To illustrate the changes through variation in relative values of different articles of product, the following is presented as showing figures for the dates mentioned, on the basis of $5 for hogs:

Value of hog products with live hogs at $5 per 100 pounds, 1889 to 1902.

[Cincinnati Price Current.]

March 1—	Green sides.	Shoulders.	Hams.	Lard.	Pork.
1889	$6.60	$5.60	$9.47	$7.62	$13.65
1890	6.25	5.35	10.74	7.73	12.66
1891	6.51	5.00	9.87	8.00	13.14
1892	6.61	5.81	9.47	7.42	13.26
1893	6.48	6.15	8.42	8.33	12.91
1894	6.52	6.08	9.24	7.63	12.89
1895	6.39	5.75	9.50	8.01	12.64
1896	6.54	6.07	10.04	6.97	12.63
1897	6.21	6.44	12.12	5.91	12.33
1898	6.74	6.40	9.26	6.78	13.19
1899	6.56	5.83	9.48	7.53	12.96
1900	6.50	6.79	10.18	6.44	12.85
1901	6.83	6.23	8.48	7.33	13.46
1902	6.94	5.83	7.98	7.72	13.65

PORK PACKING IN CANADA.

Prior to two years ago pork-packing operations in Canada had steadily increased for a number of years. During the past two years there has been a decline in this industry in the Dominion.

Official returns of the number of hogs reported on farms on July 1 are published yearly by the Province of Ontario, which furnishes the largest proportion of supplies. The following are yearly comparisons for Ontario:

Hogs in Ontario.

[Cincinnati Price Current.]

Year.	Over 1 year.	Under 1 year.	Total.
1893	220,396	791,626	1,012,022
1894	227,878	914,255	1,142,133
1895	244,185	1,054,887	1,299,072
1896	243,756	1,025,875	1,269,631
1897	235,479	1,049,484	1,284,963
1898	267,048	1,375,739	1,642,787
1899	295,349	1,675,721	1,971,070
1900	265,457	1,506,184	1,771,641
1901	222,916	1,268,969	1,491,885
1902	238,992	1,445,643	1,684,635

The number of hogs sold or slaughtered in Ontario for years ending June 30 are officially stated as follows:

Hogs killed in Ontario.

[Cincinnati Price Current.]

	Number.
1897	1,399,967
1898	1,592,679
1899	1,875,466
1900	2,056,049
1901	1,973,405
1902	1,991,907

Information obtained by the Cincinnati Price Current indicates the following as the number of hogs packed in Canada for the eight summer-season months (March 1 to November 1), the four winter months (November 1 to March 1), and total for the year ending March 1, 1875–76 to 1901–02:

Hogs packed in Canada.

[Cincinnati Price Current.]

Year.	Summer.	Winter.	Twelve months.
	Number.	*Number.*	*Number.*
1902–03	600,000	400,000	1,000,000
1901–02	580,000	390,000	970,000
1900–01	710,000	450,000	1,160,000
1899–00	877,042	614,001	1,491,043
1898–99	725,000	500,000	1,225,000
1897–98	500,000	400,000	900,000
1896–97	450,000	350,000	800,000
1895–96	400,000	350,000	750,000
1894–95	209,010	301,640	510,650
1893–94	142,550	279,920	422,470
1892–93	128,611	227,409	356,020
1891–92	99,466	251,088	350,554
1890–91	91,910	234,970	326,880
1889–90	69,436	169,273	238,709
1888–89	35,343	143,137	178,480
1887–88	70,540	145,674	216,214
1886–87	84,811	171,474	256,285
1885–86	65,230	126,660	191,890
1884–85	55,573	154,575	210,148
1883–84	37,684	99,944	137,628
1882–83	28,715	140,814	169,529
1881–82	57,016	129,971	186,987
1880–81	37,857	156,763	194,620
1879–80	37,447	157,932	195,379
1878–79	8,579	115,775	124,354
1877–78	12,957	151,781	164,738
1876–77	58,544	186,198	244,742
1875–76	25,000	119,989	144,989

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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN No. 205.

PIG MANAGEMENT.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1904.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., September 1, 1904.

Sir: I have the honor to transmit herewith a manuscript entitled "Pig Management," by George M. Rommel, Expert in Animal Husbandry in this Bureau, and to recommend its publication as a Farmers' Bulletin. This matter is reprinted from the Twentieth Annual Report of the Bureau of Animal Industry.

There is a constant demand for information such as is contained in this article, and it is believed that the publication of the manuscript in the Farmers' Bulletin series will meet with general favor among the hog raisers of the country.

Respectfully,

D. E. Salmon,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

PIG MANAGEMENT.

INTRODUCTORY.

The climate and soil which will best favor the production of any kind of live stock are those in which the same kind of stock is found wild. In his native state the hog frequents those localities where vegetation is abundant if not luxuriant. The climate is usually one of only moderate severity. If extremes either of heat or cold are common, the environment provides shelter in the dense thickets in winter and shade and an abundance of water in summer. He is a heavy and promiscuous feeder, and, therefore, in his domestic state he thrives best where pastures are most luxuriant and grain crops, nuts, or roots are most abundant. The hog is not a ranger, nor does he thrive on grass alone; he can not endure a great amount of travel at a time; exercise he must have, yet he must be able to find his feed with only a small amount of searching, and water should always be easily accessible. During hot weather he craves a pool of water to reduce his temperature, for he perspires little; and in winter he wants shelter from storms. Owing to these requirements there are few hogs in the semiarid States of the West, and in that section hog raising is coincident with irrigation and alfalfa growing.

The first place in hog raising in the United States is easily with the corn-growing sections, and here corn is the first grain thought of when the fattening of animals, especially hogs, is mentioned. It is, however, fallacious to argue that hog feeding will not give profitable returns outside of the corn belt. The corn belt has wonderful advantages for economical pork production, but it also has its disadvantages, one of which is the bad effect on fecundity of feeding too much corn to breeding stock. Any locality that will grow clover of any species, that is favorable to the production of alfalfa, peas, or beans, or where grains are readily grown—not only corn, but barley, wheat, oats, or rye—will be a favorable situation for the successful production of pork. If it is a locality where dairying is common, no better advantages are required; for, given leguminous pasture—clover, alfalfa, peas, beans, etc.—as a basis, with a grain feed that can be readily grown and also dairy by-products, the very highest grade of pork can be produced at a minimum cost. Variety of feeds alone is an item of

immense importance in feeding. An animal tires of a constant ration of one kind, and is more easily put "off feed," at such times than when he is occasionally supplied with a change to keep his appetite keen. Not only has variety of feed an influence on appetite, but it results in a better quality of pork.

The few States comprising the corn belt are in reality the source of supply for a great amount of the meat product, especially hams and bacon, that is consumed in other portions of the country. Yet the advantages of many of these corn-belt States are little, if at all, superior to those outside of that district. The South has an abundance of vegetation. Cowpeas, velvet beans, and peanuts are leguminous crops that are peculiar to that section. Corn grows readily in all parts of the South, and in the subtropical portions the experience of feeders with cassava seems to indicate that it has considerable value for pork production. In addition, there is generally an abundant water supply; the climate is mild, and there is a long period during which green feed is available; the expense of shelter and winter feeding is very greatly lessened. These conditions, giving a long period of pasture and outdoor life, enhance thrift, and with proper management insure great freedom from disease.

In the extreme West the alfalfa of the irrigated valleys and the clover of the coast districts give a splendid foundation for successful pork production. In most of these regions there is an abundance of small grain, particularly barley, that may often be fed economically, while in some localities corn is a successful crop.

Barley is of so much interest and importance in the production of prime pork that it demands more than a passing notice. This grain has not been relied upon to a great extent in America as the principal part of a hog-fattening ration, but the practice of Danish farmers and the results of experiments can very well be studied with profit by American feeders. The Danish bacon, which figures so prominently in the English markets, is produced mainly with barley and dairy by-products. At the Ontario Agricultural College, Day has found barley so valuable in the production of prime export bacon that it is now used as a standard with which other grains are compared. In his experiments to determine the nature and causes of "soft" pork, Shutt found that the best bacon produced was by a ration in which barley was at least one-third of the whole amount. Farmers in those parts of the country where barley is a prominent crop can well devote attention to their opportunities for pork production; besides, in addition to this grain, some of the leguminous crops can often be grown for pasture, thus furnishing materials for a well-balanced ration.

The grain-growing districts of eastern Oregon and eastern Washington are instances of such localities. Corn is raised there to a very limited extent, but barley is an abundant crop and can be produced at

minimum cost, and often wheat may be utilized. In nearly all parts of this section there are irrigated valleys where alfalfa grows abundantly. Yet every town and city in this section imports immense quantities of pork products from the corn belt; indeed, it has been stated that 75 to 90 per cent of all the hams and bacon sold at Spokane are shipped in from the East; and when one remembers that this city feeds a very great territory it is readily seen how great is the dependence on the corn belt.

Recent investigations, the results of which have been published by Elliott, of the Washington Station, and Withycombe, of the Oregon Station,[a] show a greater feeding value for wheat than for barley. They seem to indicate that, under those conditions, it may be necessary to test barley further before its value is definitely determined. The grains were crushed in all cases. It would be interesting to note the effect of eliminating the hulls of the barley or feeding crushed bald barley in comparison with wheat or a mixture of wheat and corn. The bad effect of oat hulls on young pigs is well known. Possibly barley hulls had an injurious effect on the digestion in these tests.

The purpose of these remarks is not to minimize the value of corn in meat production of any kind. Corn is, perhaps, with a favorable climate and soil, the most economical grain that is at the command of the stock raiser and feeder of the United States. It is nutritious and highly palatable. Without its use it is difficult to imagine how the animal products of the United States could have attained their present position in the world's commerce; and so long as meat products are a factor of American agriculture corn will probably be a leading factor in meat production in this country, and the corn belt will naturally continue to be more or less the center of feeding operations. On the other hand, the condition is ever present that farmers in localities where corn is a limited product have their own wants to supply. If, in addition to their own needs, the farmers of these localities can supply a share of the export demand, great strides will have been taken in their agricultural development, for "live-stock husbandry is the foundation of successful agriculture." A market for the surplus is, of course, essential, but where a supply is available the market will probably grow up.

HOUSES, INCLOSURES, FENCES, ETC.

THE HOUSE AND ITS LOCATION.

Hogs are notably affected by extremes of heat and cold, and the character of their shelter will therefore depend on the locality. If the locality is one of severe winters, warm quarters are a necessity

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[a] Bul. No. 58, Washington Expt. Sta., and Bul. No. 80, Oregon Expt. Sta.

and an extensive piggery may be erected. Four things should be especially considered in its construction—(1) light, (2) ventilation, (3) warmth, and (4) cleanliness. Under cleanliness, ease of cleaning and dryness must be regarded. A well-drained location should be chosen; one that will give the hogs a good climb to reach it will provide needed exercise. The house should be on a north and south line, so that both sides may receive direct sunlight during a part of the day. Mr. John Cownie,[a] of Iowa, recommends a house with a wide driveway, with pens 6 or 8 feet square on either side opening into the driveway, and each pen provided with a window for light and ventilation. Mr. L. N. Bonham,[b] of Ohio, recommends a house with a row of sleeping pens on either side of a cement-floored alley, opening into feed pens floored with cement. The sleeping pens are floored with boards laid in gravel or cinders. Paving brick costs about twice as much as cement.

FIG. 1.—Hog house for Northern latitudes, end elevation.

Figure 1 shows a rough sketch of a house arranged on plans similar to these. Figure 2 shows the floor plan of the same house. The pens are 8 feet square. Each pen has two doors and a window. One door opens into the driveway and the other into the feed pen. If it is desired to protect the hogs from visitors, it may be found well to dispense with the door into the driveway, in which case the latter need not be wider than necessary to permit driving through with a wagon. The windows open downward. Ventilators are provided in the roof. The feed rooms are located in either end of the house. They should be at least as large as the pen, and may be on either side of the driveway or extend entirely across the end of the house. In the latter case the driveway should be dispensed with or made wide enough to enable a wagon to turn around in it. The width of the driveway will therefore depend on the presence or absence of this middle feed room.

a Thirteenth Biennial Report of Kansas State Board of Agriculture, p. 695.

b Breeder's Gazette, February 18, 1903.

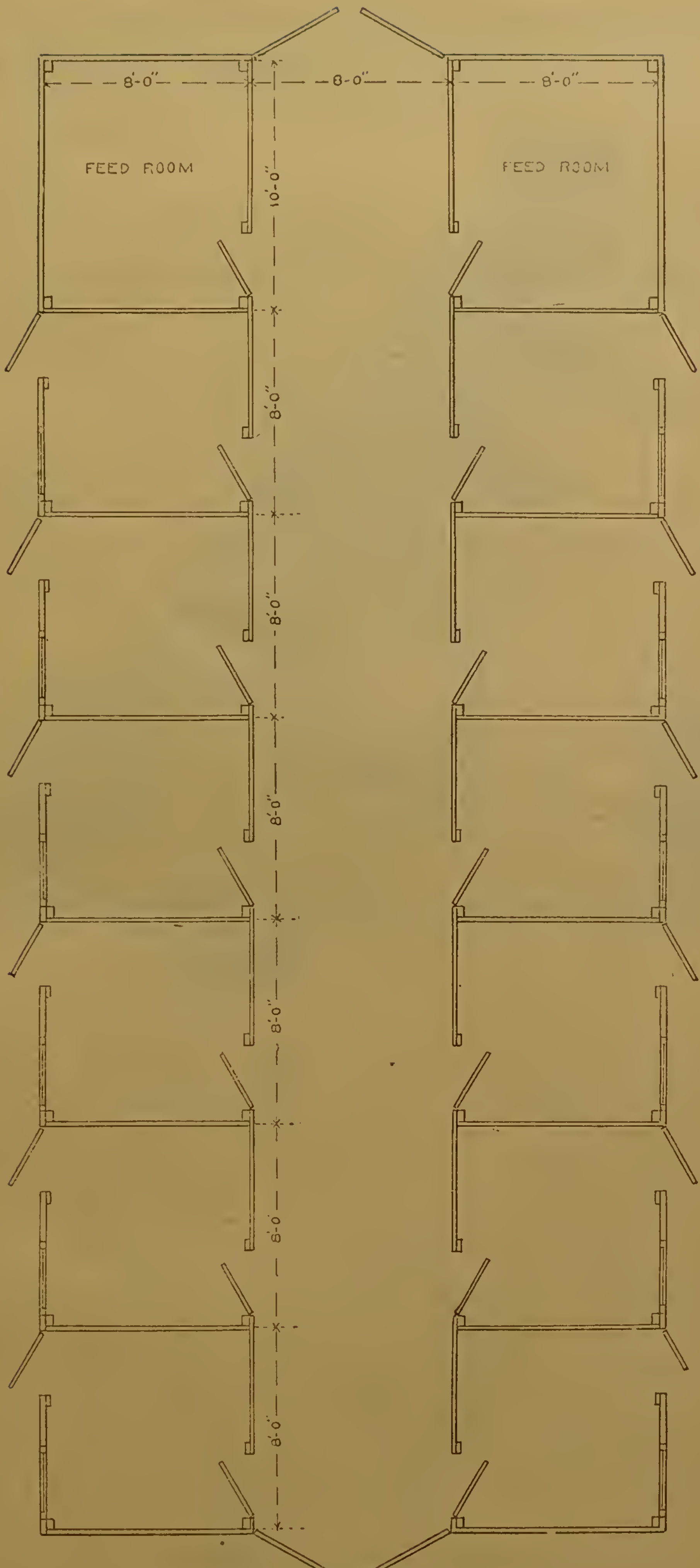

FIG. 2.—Hog house for Northern latitudes, floor plan.

If no other means of ventilation than the windows is provided they should be so arranged that entering air currents will be directed

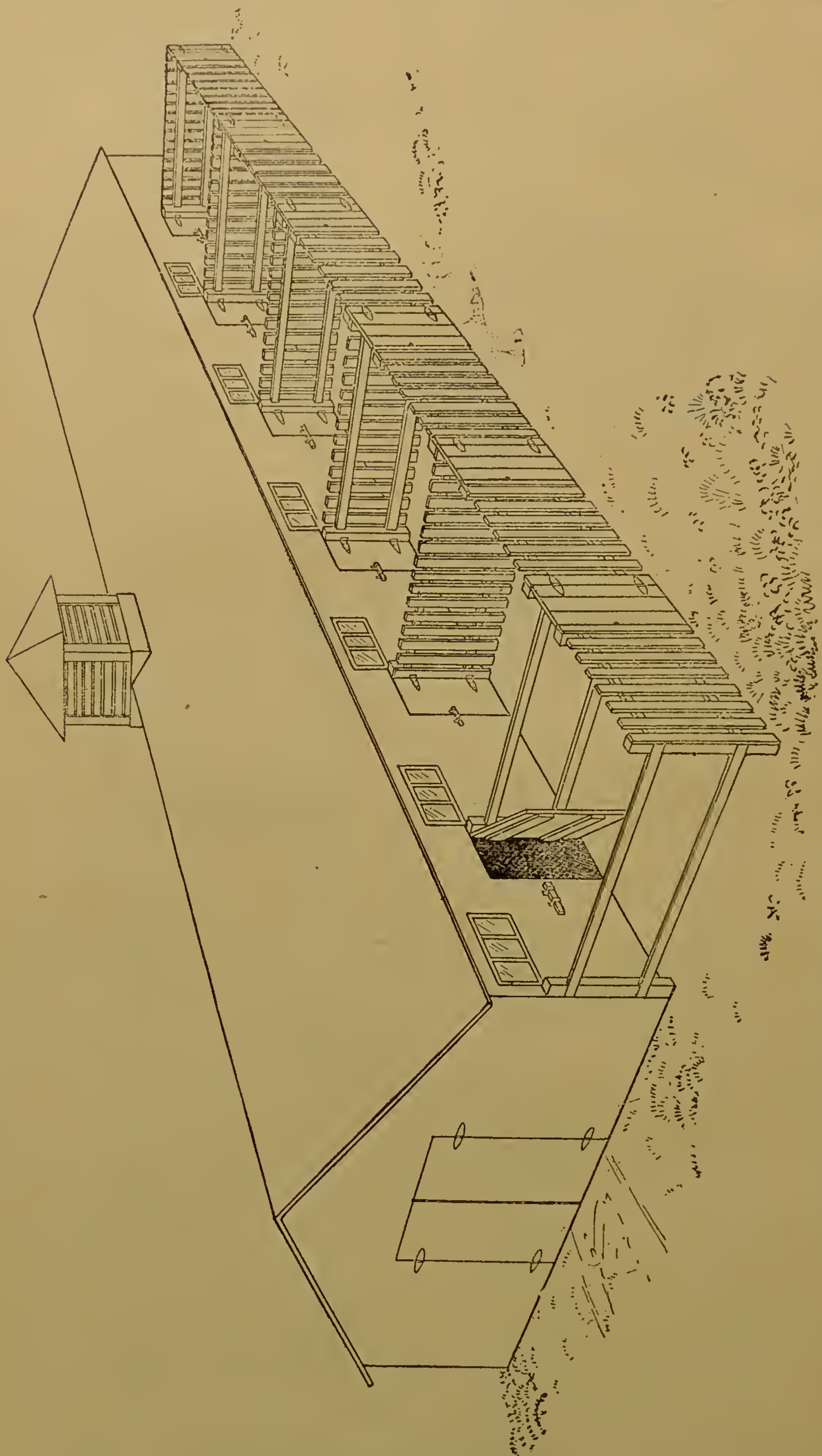

FIG. 3.—Hog house for Northern latitudes, side elevation; showing arrangement of outside feeding pens.

upward when the windows are opened and direct drafts on the hogs avoided. The size of the house and its equipment will depend upon

the size of the herd and the resources of the owners. Not more than fifty breeding hogs should be confined in one house; sanitary considerations make a smaller number much safer. Out of doors the number of hogs in one inclosure may be increased considerably above fifty without danger.

The arrangement of the pens will depend largely on the climate and the convenience. A very common plan is to have only the sleeping pens under cover, building feeding pens of the same size just outside the hog house and adjoining it. If these pens are floored substantially with concrete, they will last well. If the floor is properly laid, fitting closely to the posts and baseboards, there will be little danger of the hogs doing damage to the walls of the house by rooting, and rats will be prevented from burrowing under the walls.

Figure 3 shows this arrangement of pens for the house in figure 1. The advantage of this plan is that the sleeping and feeding pens are separate. The main part of the manure will therefore be left in the

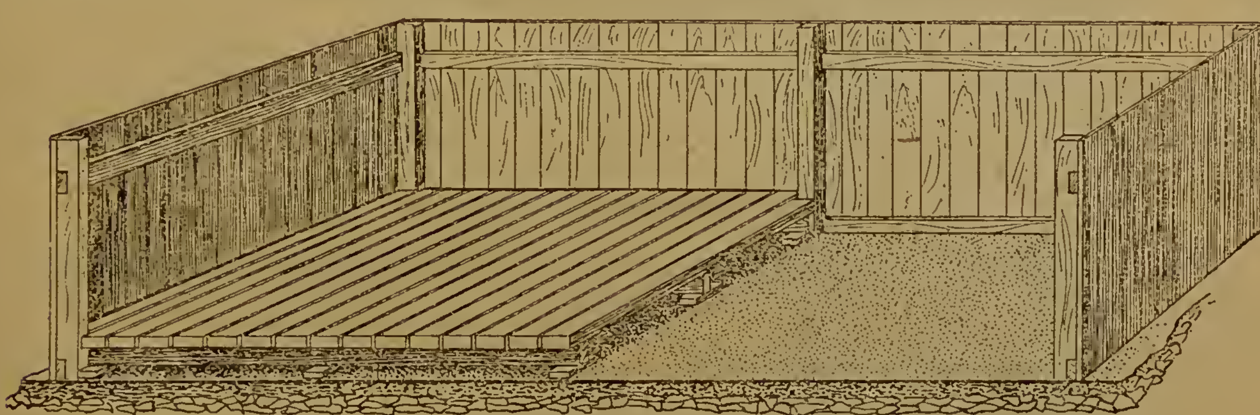

FIG. 4.—Pen arranged with sectional floor.

outside pens and can easily be removed. If separate feeding of the pigs is not necessary, the outside feeding pen need have no partitions. This arrangement will doubtless be more convenient for those who breed only for the market. The feeding pen connects with the pasture.

Where it is desirable to have both sleeping and feeding pens under cover, the pens in the house can be enlarged. A convenient plan for such a pen is used by the Michigan Agricultural College. The pens are 8 by 16 feet. A false wooden floor is built, of strong material, usually 2 by 4 inches, in two sections of equal size. This false floor is made small enough to fit conveniently into the pen, and rests on cleats in the bottom of the pen. As a rule only one section of the floor is used at a time, this part of the pen being kept bedded and used as a sleeping pen and the remaining part being used as the feeding floor. (Fig. 4.)

Under any circumstances the house should be well constructed and warm. If boarded up inside with good matched siding, such a house will be comfortable in zero weather, and sows may farrow there with

safety. Concrete or brick floors are expensive, but if the initial expense can be incurred and the floors are well laid they will pay good interest in the saving of manure and the dryness of the house. Animals should not be compelled to sleep directly on such floors, for rheumatism and colds are very likely to result. The best floor for a sleeping or farrowing pen is one of wood on concrete, the wood being 2 by 4 inch timbers, laid from one-fourth to three-eighths inch apart to allow drainage. If not constructed in this way concrete and brick floors should be kept well littered. A clay or ordinary earth floor is excellent, and by some preferred to any other. It is the warmest floor, but not so easily kept clean as one of brick or concrete. If a house is constructed with earth floors care must be taken that the floors are well drained, both underground and on the surface.

The greatest necessity for a good house is at farrowing time, for it is then that more pigs die than at any other. If the sow farrows in a damp or cold place or in drafts, serious results to the sow or the pigs or to both will follow. At this time the sow is seriously weakened, and she is very susceptible to exposure, while newly born pigs are easily stunted or killed by chilling. Rheumatic complaints are common with pigs, and are often caused by damp, chilly sleeping places.

PORTABLE HOUSES.

The portable house is coming into very general favor, especially in disease-infested districts. They are of various forms, and should be large enough for five or six grown hogs, with enough height to allow

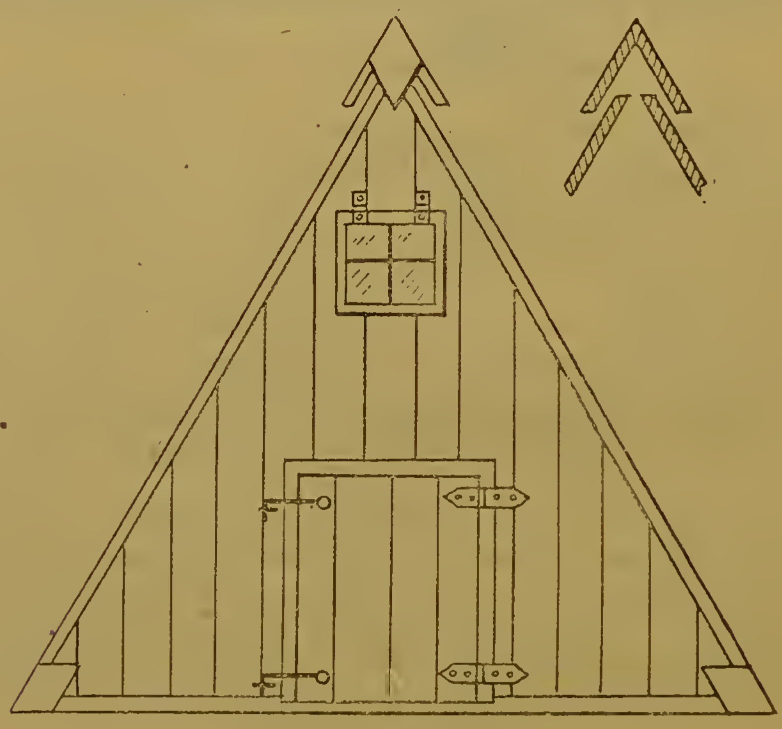

FIG. 5.—Lovejoy portable hog house, end elevation.

a man to stand erect; 6 by 6 feet or 8 by 8 feet are good sizes. Such houses should be strongly constructed of good lumber, with perfectly tight siding and roof. They may be made with or without floors. If

lined inside with the same materials as outside, such a house will be warm enough for a sow and pigs in zero weather; and on extremely cold nights a lantern hung in the house will provide warmth enough.

The plans for a portable house used by two successful breeders—Mr. A. J. Lovejoy, of Illinois, and Mr. L. N. Bonham, of Ohio—have recently been described in the agricultural press, as follows:

The Lovejoy pens or portable houses are each situated in the middle of an acre lot and on either side of a driveway, the divisions being made by the use of wire fencing. The houses are 8 feet square. Four 16-inch boards make the floor, and the roof and sides are made of matched flooring lined with building paper, and that covered on the inside with common lumber. The houses are set to front south. There is a door in both north and south ends, and a window in the south end, the latter being hinged at the top with a rope and pulley attached, so that it can be swung up out of the way when it is open. In cold weather and early spring the north door is closed, and, if necessary, the south openings are also closed, fresh air being secured through the ventilator in the roof by carrying the ridge a trifle higher than the sides that comprise the roof. [Fig. 5.]

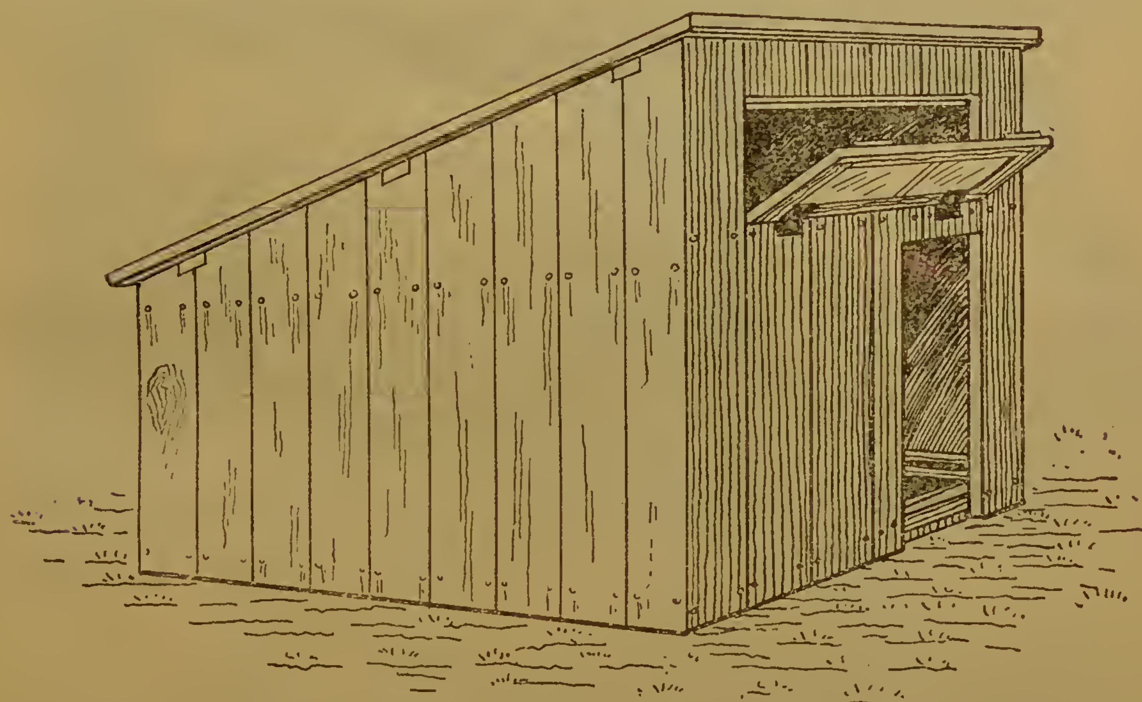

Fig. 6.—Bonham portable hog house.

In hot weather the houses are converted into summer resorts by leaving both doors and window open. Each house is nicely painted with two coats and trimmed in white, and costs, complete, about $10. They are set up on blocks in the summer to keep the floors dry, and in the winter time they are dropped to the ground and banked to keep the wind out from under the floor.

The primary object of the Bonham pig house is to secure shelter, warmth, sunshine, and pure air at reasonable cost, and the secondary object is to have it as handy for feeding and handling the sows and pigs as possible.

For some sows the main roof may be shortened 18 inches. This will give a pitch to the front, and a sash 6 by 1½ feet in front to let in the sunlight and keep out the rain and cold may be provided. This adds a little to the cost, but makes an ideal shelter for spring litters, when sunshine is never in excess and of inestimable value. In very cold weather we add a swinging door, but a gunny sack hung at the top of the door will do. If the weather is below zero and windy, a lighted lantern hung to the roof inside until the pigs are dry and have had their first meal of the sow's milk will

keep them comfortable in the coldest weather. The warmth of the sow is sufficient in other weather to keep the pigs comfortable in such a pen.

This house is 5 by 6 feet. Four scantlings 2 by 2 inches by 12 feet, and two scantlings 2 by 4 inches by 12 feet will make the frame and roof supports. The bottom rail is 2 by 4 inches, the others 2 by 2 inches. The three pieces for the roof are cut 6 feet by 6 inches to give a 3-inch projection of the roof beyond the sides.

[Figure 6 shows the house set up and the drop window partly down. Figure 7 shows the top off.] The construction is readily seen. After the house is ready to set together have the floor made just large enough to let the sides of the house set outside the floor. The cost of this house is about $5. It pays to paint the roof every three years, but the sides will last without paint as long as the roof is well painted. Taken down each fall and spring and whitewashed and set up against a fence or in a shed until needed, it will give long service.[a]

A chief advantage of a portable house over the piggery system of several pens and a large number of hogs under one roof is its ease of management in times of epidemic. Only a few animals can be kept

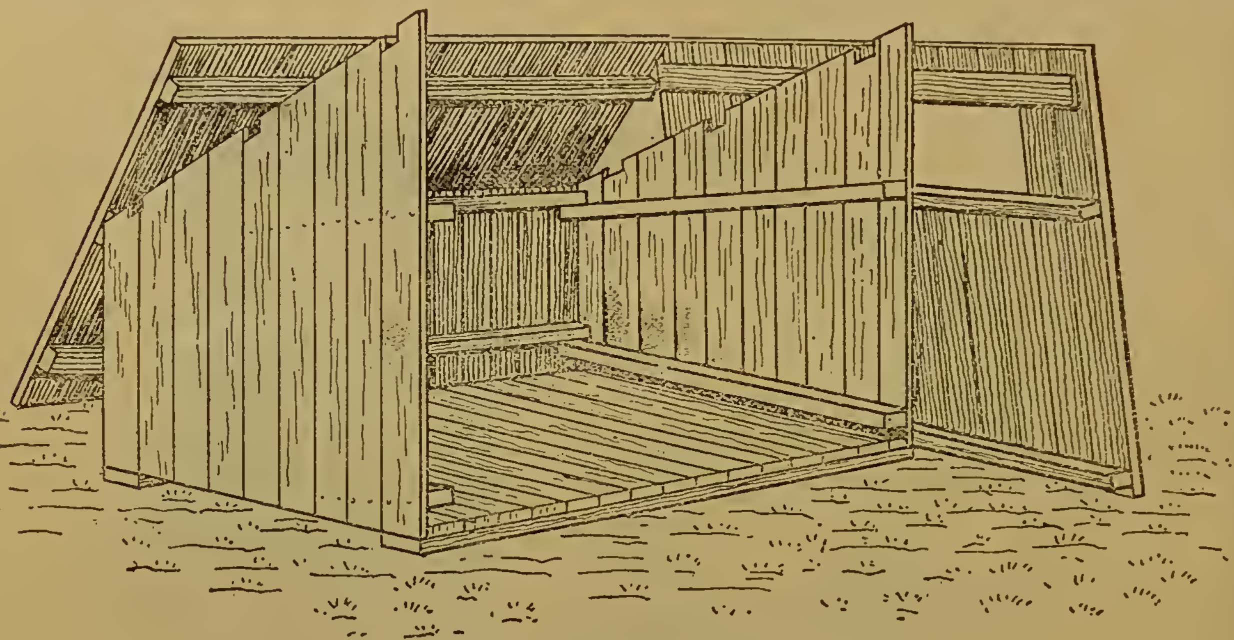

FIG. 7.—Bonham portable hog house, showing plan of construction.

in one pen, and the isolation of the diseased animals when an outbreak begins is thus rendered comparatively easy. When cholera breaks out in a crowded piggery every animal in the building is exposed, and the farmer, though he may isolate the unaffected animals at once, does not know how soon the second outbreak will occur; he has no check whatever on the epidemic. But with portable hog houses each house is itself a cholera check, and only infection directly from diseased animals can spread the disease.

HOUSING IN MILD CLIMATES.

In the South and in much of the country west of the main chain of the Rocky Mountains the winters are sufficiently mild to obviate the necessity of constructing buildings of much warmth. Not only are

[a] Breeder's Gazette, January 6, 1904.

the winters mild, but they are comparatively short, and green feed is available much longer than in other parts of the country. In such localities a shed will often suffice, but it should be well constructed, in order to provide protection from storms and damp, chilly weather.

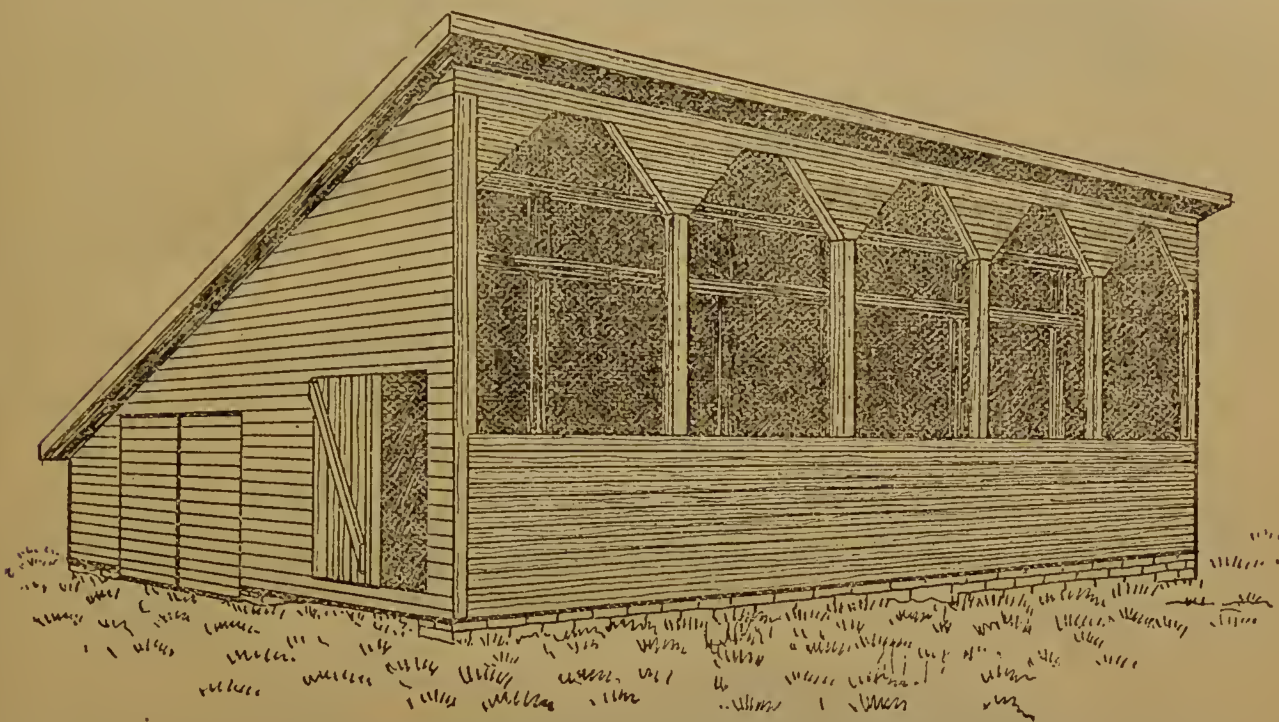

FIG. 8.—Hog house for Southern latitudes.

The location, as that of a piggery, should be high and well drained, affording clean, dry sleeping places; the shed should open to the south. The expense of such a building is well warranted in view of the added comfort to the stock and increased number of pigs raised. Under all

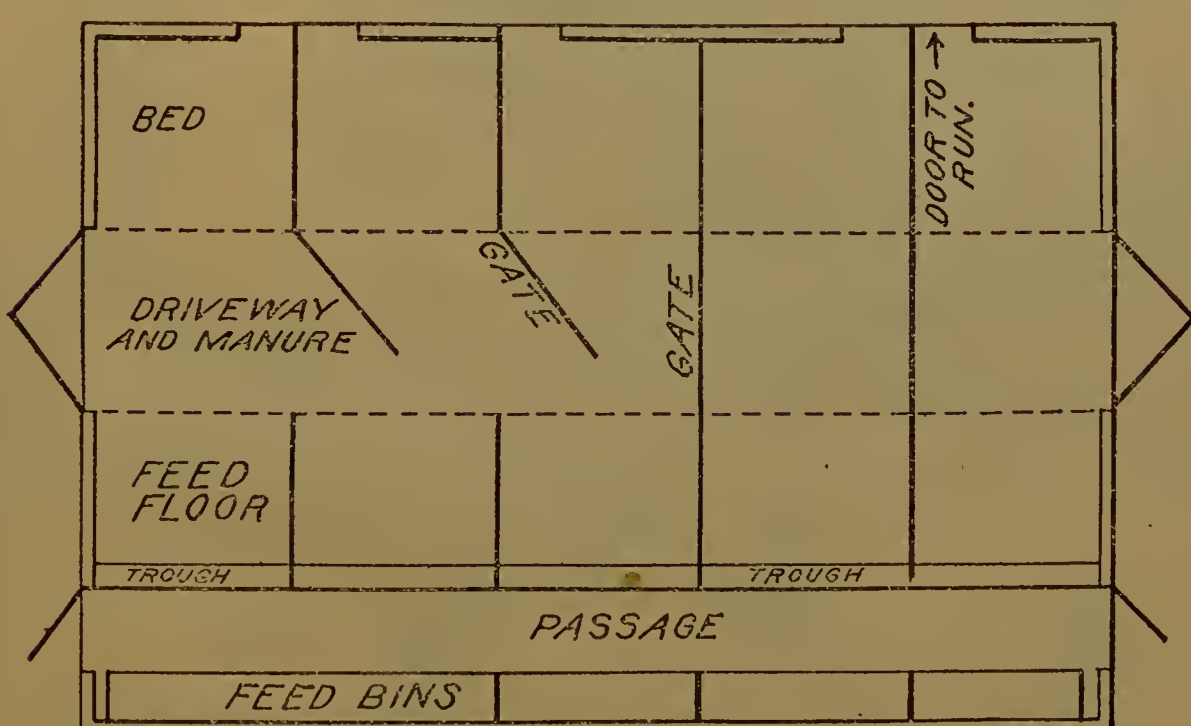

FIG. 9.—Hog house for Southern latitudes, floor plan.

circumstances, regardless of climate, whether a man is breeding pure-bred stock or grades, hogs should have sleeping places that are dry and warm and feeding places that are clean.

Figure 8 shows the elevation of the house used by the Maryland Agricultural College, at College Park, Md., and figures 9, 10, and 11 show the ground plan, the end elevation, and the arrangement of the

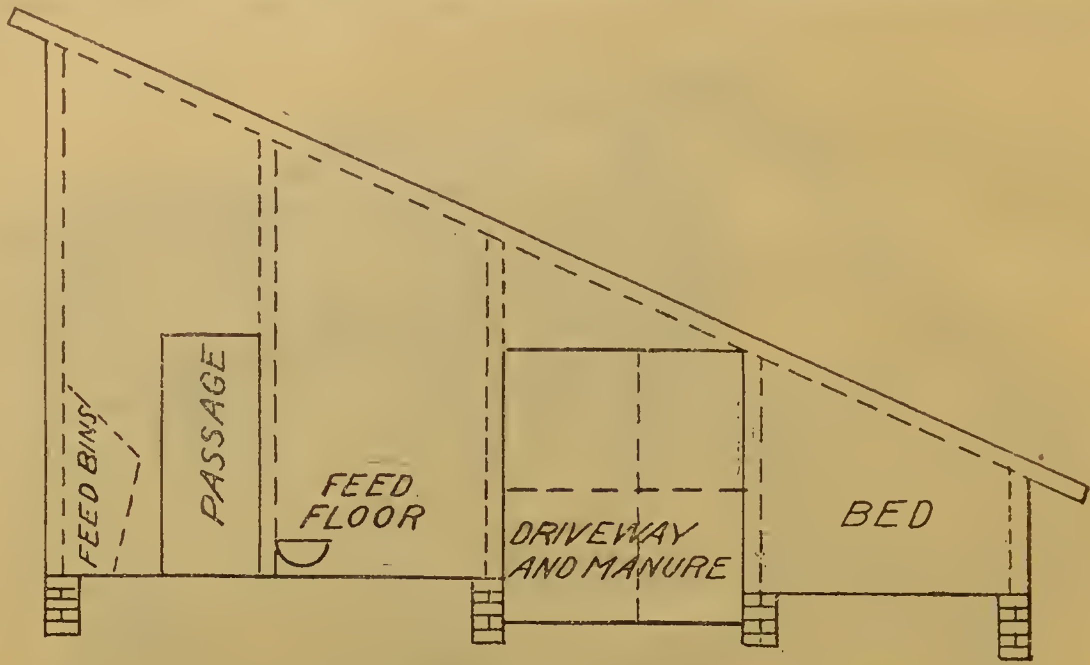

FIG. 10.—Hog house for Southern latitudes, side elevation.

troughs and feed bins.[a] The front faces south, and is open and raised sufficiently to allow the sun's rays to penetrate to the extreme end of each pen. Sunlight and ventilation are thus provided by the same

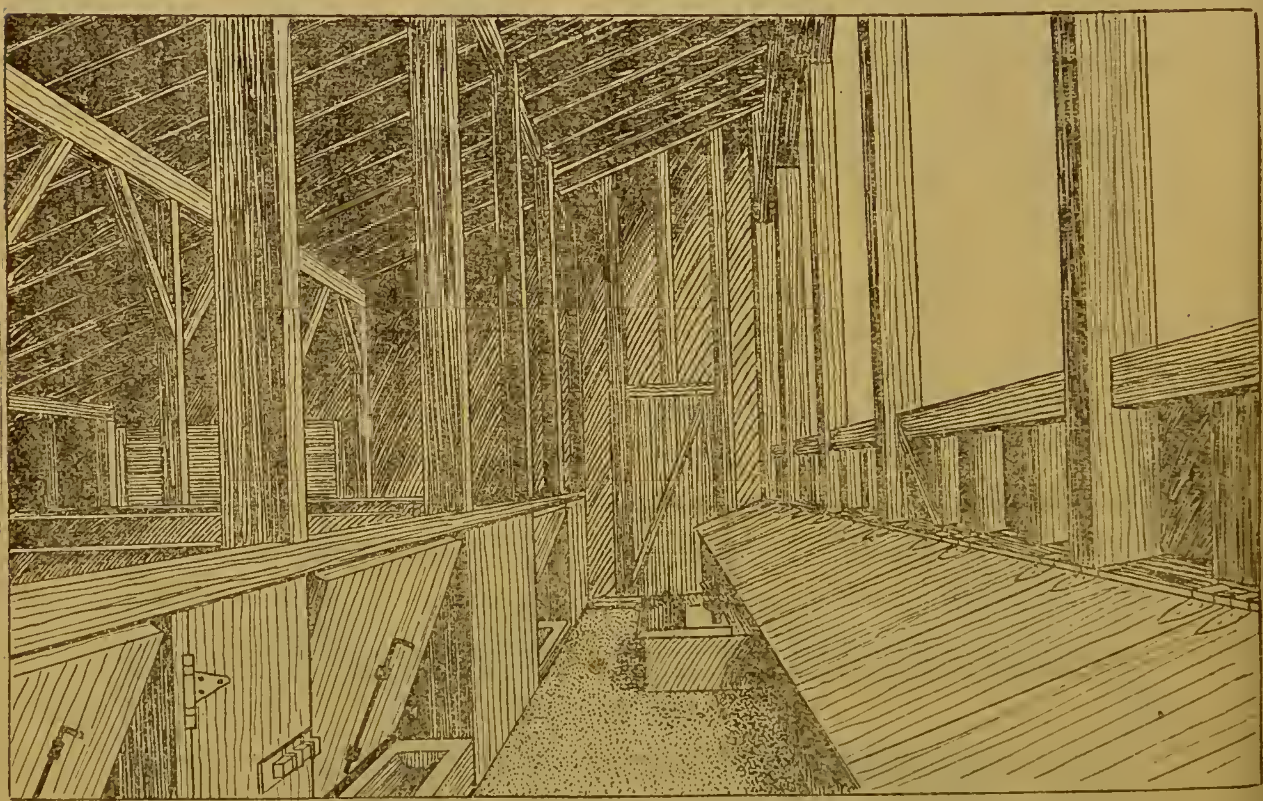

FIG. 11.—Hog house for Southern latitudes, showing arrangement of troughs and pens.

means. The feed bins are placed against the front of the house, a passageway intervening between this and the pens. The pens have

[a] From Bul. No. 63, Maryland Expt. Sta.

swinging fronts, so arranged that the feed can be placed in the troughs and evenly distributed before the pigs get to it. Back of the feeding floor is a depressed driveway, which is kept well bedded, and serves also as a manure pit, and at the rear of the house are the sleeping pens, from which doors open into the yard. The feeding floor and sleeping pens slope slightly toward the driveway. The gates of the sleeping pens extend entirely across the front and are the same width as the driveway. These gates are opened across the driveway except when cleaning; at this time, the hogs are driven into the sleeping pens or on into the yards, the gates of the pens closed on them, and the cleaning proceeds with no interruption from them. The gates and partitions between the pens are constructed in lattice fashion, which allows free circulation of air.

TROUGHS.

Well-made troughs are a necessity in pig feeding. The time-honored V-shaped trough (fig. 12) is very common and doubtless familiar to all who handle hogs. Some farmers use troughs made of logs (fig.

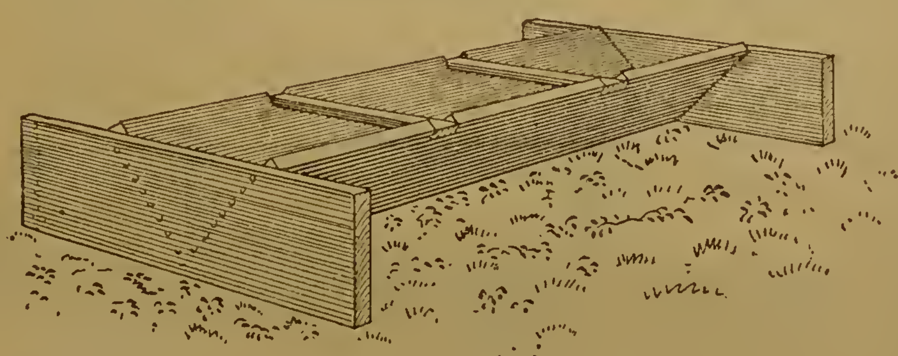

FIG. 12.—V-shaped trough.

13), which are adzed off on one side to give a level resting surface and hollowed out on the other. This is a durable trough, but it is very cumbersome.

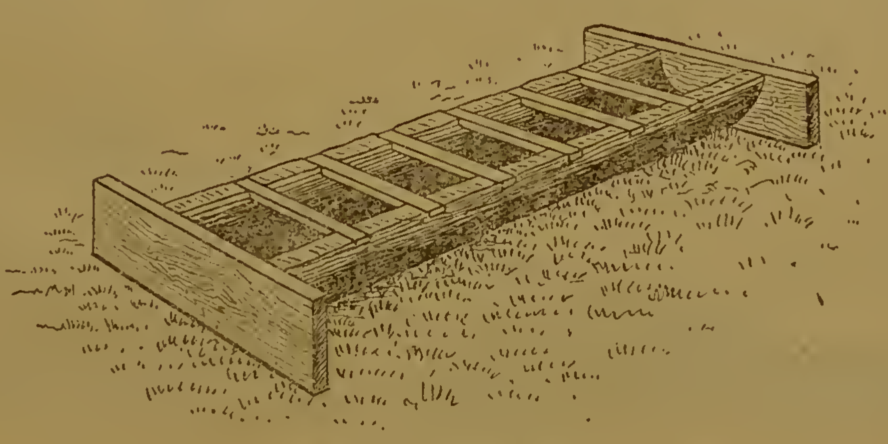

FIG. 13.—Log trough.

Theodore Louis advises the use of a low, wide, shallow trough (fig. 14). Troughs should not be so long that they can not be handled by one man, and they should be so strong that they will not readily be broken to pieces by the pigs.

A very convenient arrangement of the feeding troughs is shown in the drawings of the Maryland Agricultural College hog house. The troughs extend across the front of the pen and are built solidly, so that they will not be displaced. The front of the pen is hung on hinges, and attached to it is a strong iron rod which fits into holes in the edges of the trough and holds the pen front firmly. When feeding the pen front is swung back and the rod inserted in the edge of the trough. The pigs can not then get to the feed until the front is lowered. The plan permits feeding without being disturbed by the eagerness of the animals, and the feed is evenly distributed. (See figs. 11, 15, and 16.)

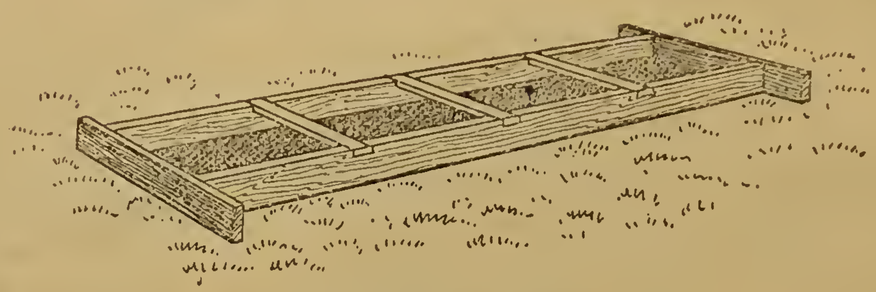

FIG. 14.—Shallow trough.

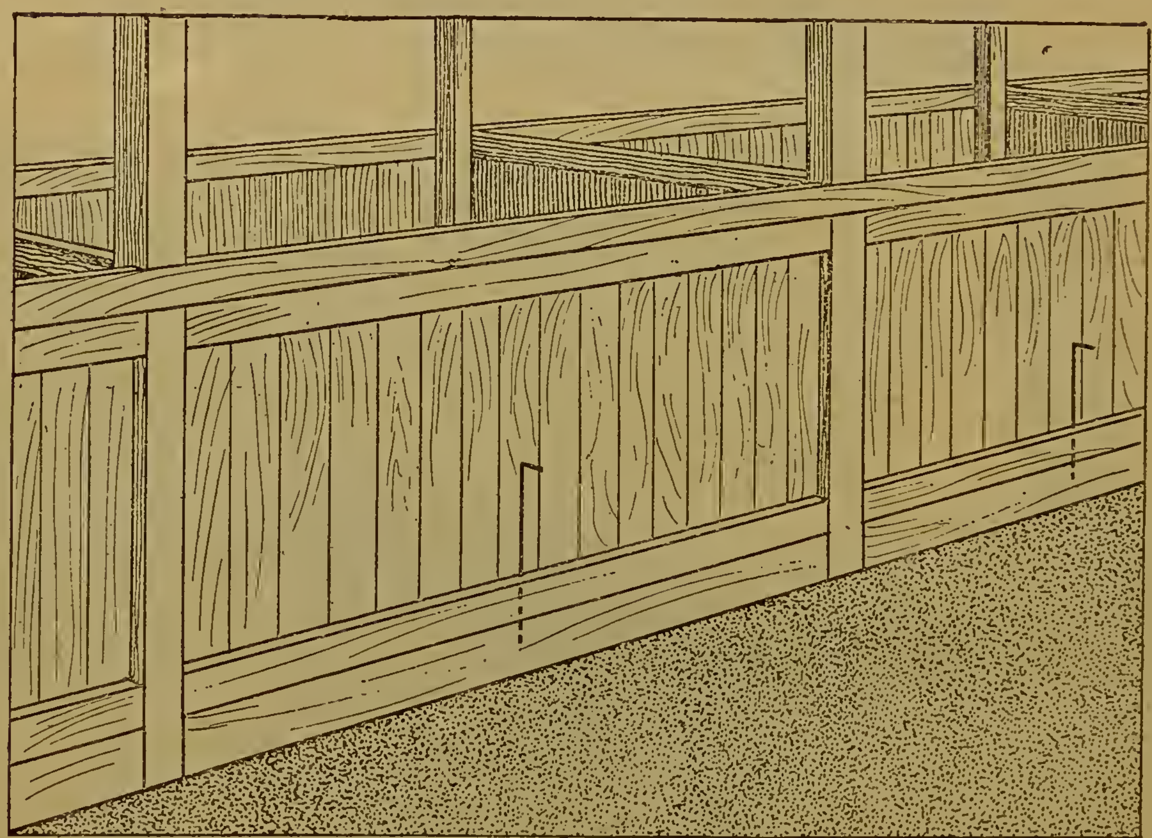

FIG. 15.—Pen with swinging front, closed.

Wooden troughs are objectionable in some respects. They are not very easily kept clean and are not durable. Iron troughs are used to a considerable extent and have much to commend them. They are more sanitary than wooden ones, and with proper care will last indefinitely.

PENS AND PASTURES.

The question of pens and pastures, both as to size and location, must be determined by each one for himself. Local conditions, expense, and convenience must be considered. A good rule to follow is to favor large inclosures rather than small ones. A number of pens and several pastures will be found a convenience and are particularly valuable when disease makes its appearance, as hogs affected may then be removed at once. A quarantine pen with an absolutely tight fence should be arranged on every farm where hogs are kept. Here all newly purchased hogs should be confined after arriving at the farm until all danger of infection is past.

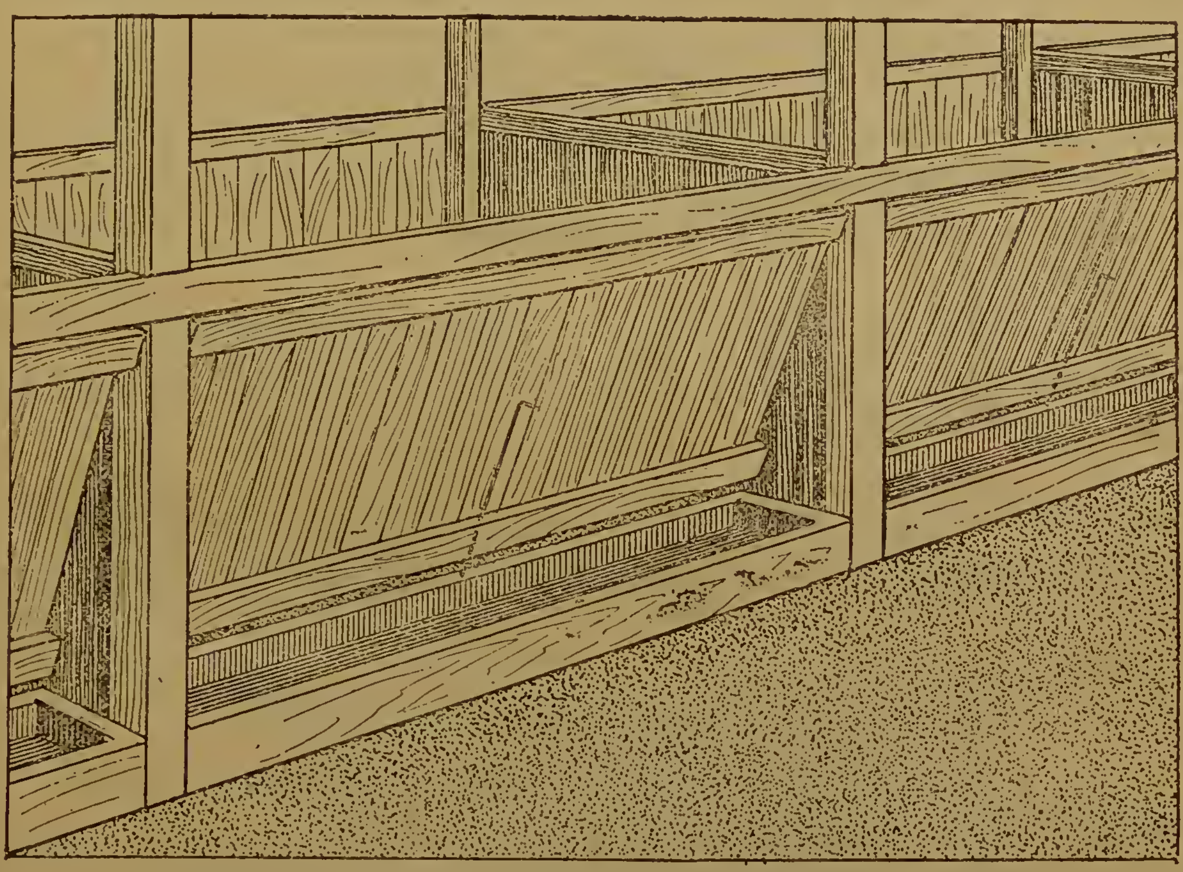

FIG. 16.—Pen with swinging front, open to allow filling of troughs.

It will generally be a satisfactory practice to keep hogs away from other stock, except when following fattening steers. Pregnant brood sows should never be allowed to run in the same yards or pastures with cattle, horses, or mules. Many good sows have been ruined by the playfulness or viciousness of the larger farm animals.

The pen and yard for the boar should be separate from the rest of the herd and out of sight of it. The pen should be so strong that the boar can not tear it down or go through it, and a tightly fenced pasture of one-half to 1 acre in area should adjoin.

A "down"[a] pigging sow, if she is to farrow in the piggery, can have the run of the alley for exercise. If she has a house to herself, a small yard should adjoin.

[a] A sow about to farrow.

FENCING.

No man should attempt to raise hogs without adequate fencing of yards and pastures. An animal of any kind, but especially a hog, can make himself an intolerable nuisance if not confined within proper bounds. For pastures woven wire is the best fencing material, all things considered. Such a fence may be purchased ready-made or may be made on the farm by machines. There are several good kinds on the market. From motives of economy, it may be desired to run a fence of woven wire around a field to a height of 30 to 36 inches, and above this to stretch two or three strands of ordinary barb wire. This will make a hog-tight fence, and if horses are necessarily placed in the field the fence will be much safer than the ordinary one made entirely of barb wire. Midway between the posts the lower strand in the fence should be securely stapled to a small post or stake; this will prevent hogs from working their way under the fence. In building any kind of wire fence ground wires may be put down to moisture at frequent intervals to give stock protection from lightning.

A board fence makes, perhaps, the most secure inclosure for hogs, but its expense precludes its use generally except for yards and pens. These should always be of boards, stoutly nailed to strong, well-set posts.

Barb wire is very poor material for a hog fence. It can hardly be made close enough or strong enough to prevent a shoat from crawling through. In this respect it is only a little better than a hedge, which is expensive and unsatisfactory when used to confine stock. Gates must, of course, be carefully made, hung, and fastened.

PORTABLE FENCES AND HURDLES.

When hogs are run on annual forage crops, such as rape, rye, wheat, oats, or sorghum, temporary fences are almost absolutely necessary. They should be light, strong, and portable. A plan for such a fence

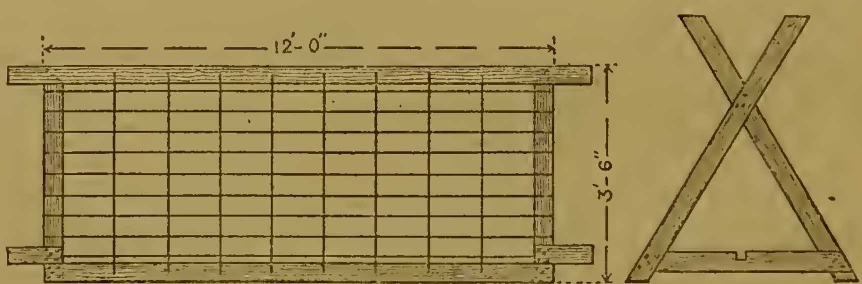

FIG. 17.—Wing's portable hog fence.

is seen in figure 17. It was designed by Mr. J. E. Wing, of Ohio.[a] Concerning this fence, Mr. Wing says:

> Perhaps the combination of wire and wood will serve best; it is light, cheap, and if good wood be used, is durable. Get something that will not warp or twist. Hem-

[a] Breeder's Gazette, February 3, 1904.

lock will serve, and 1 by 6 inch stuff is heavy enough, though if it is to have much hard use, 2 by 6 inch will be better. The illustration [fig. 17] shows clearly how it is put together, with long nails clinching or bolts. Buy wire fencing, cut it into suitable lengths, leaving the ends long enough to pass clear around the end pieces and tie Tie the wire also to the horizontal pieces at intervals.

Except for special purposes it is better to buy woven-wire hog fencing, stretch it about the land to be pastured off, support it by stakes, and when through with it roll it up again and take it away.

Figure 18 shows a diagram of a hurdle which is very useful in catching hogs or driving them for short distances. This hurdle is made of 2½-inch stuff, 8 feet long, and the strips 3 inches apart, making the sections 30 inches high. Two sections of this size are hinged together. The hurdle is arranged with a hook and staple. A second hurdle may

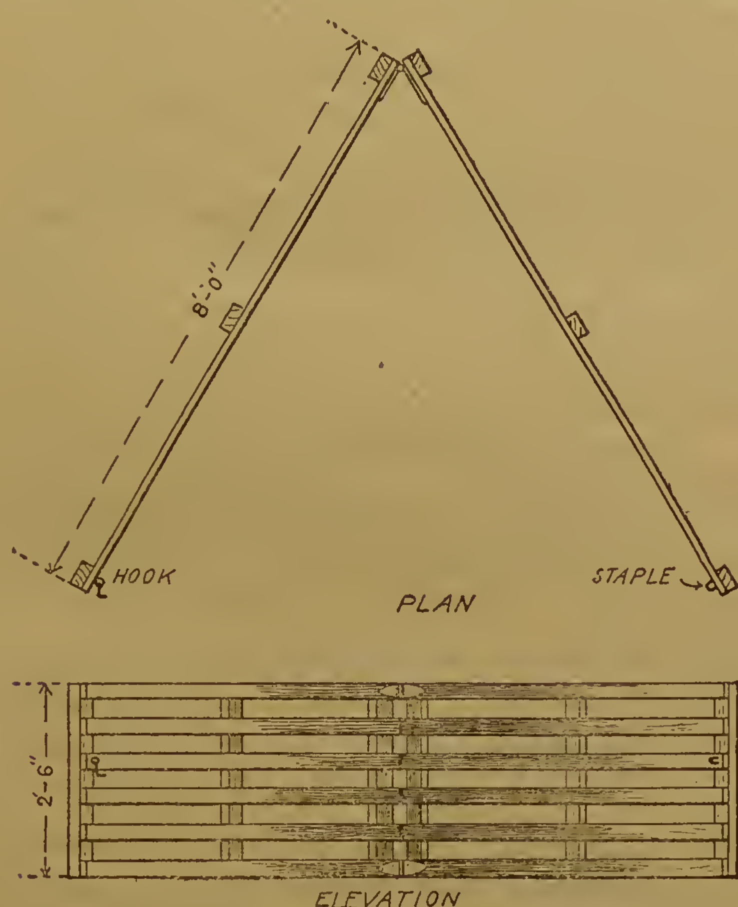

Fig. 18.—Hurdle.

be made, with hook and staple to correspond with this, and when hooked up, the two make an inclosure 8 feet square, which is very convenient for confining hogs for exhibition or sale.

THE FOUNDATION HERD.

SELECTING THE SOWS.

The first selection of breeding stock is of prime importance. The effects of mismating are always difficult to breed out of a herd, and the effect on a beginner is such that a mistake may completely discourage him. It is good economy to make haste slowly at this time. The start should be made with a few animals; five sows will make a

large enough herd for the first year. They should be good individuals, and it will even be much better to buy one high-class sow than five poor ones. This will be real economy, and the development of the herd will prove its value. It will be well if a beginner can obtain the assistance of an old and successful breeder in making a start.

The expression "the male is half the herd" is repeatedly quoted. So far as our knowledge of heredity has developed, other conditions being equal, there is uniform prepotency in both sexes; the influence of the two parents on the offspring is theoretically equal. Therefore, if the boar is half the herd, the sows certainly make up the other half, and their selection is a highly important matter. They may be purchased, already bred, some time before the boar, and quite an item of expense will thus be saved. Then by the time the sows have been watched and studied for a season and have each raised a litter of pigs, the owner will be much better prepared to select a suitable male, and he can then get one to use on both dams and offspring.

The sows selected should be nearly the same age, which should be about twelve months, and all should be safe in pig, preferably to the same boar. Their individual characteristics should, perhaps, be first looked to. While hogs do not show the strong differences of sex that we look for in a cow or a mare, sex characteristics always constitute a marked feature of a good brood sow. The smoother forehead and lighter, finer neck are points of distinction from the signs of masculinity in a boar. The forehead should be broad between the eyes, the throat clean and trim, the neck moderately thin, and the shoulders smooth and deep; the back should be fairly wide and straight, and ample room for the vital organs should be provided by a good width and depth of chest, well-sprung ribs, and straight, deep sides—a deep, capacious body from end to end. Depth of chest and abdomen are specially important in a brood sow. Pinched chests and waists must be avoided. It is generally advised that sows with much length of body should be selected for breeding purposes, length of body being regarded as an indication of fecundity. It will certainly do no harm to select sows that are especially long, but care should be taken that quality go with the increase in length. The loose-jointed, long-coupled, slow-maturing, and slow-fattening type should not be allowed to get a foothold in the herd. The influence of length of body on a sow's fecundity is by no means positively known. Many very short-bodied sows have proved to be wonderfully prolific breeders. The surest means by which to select prolific sows is to keep an accurate record of the herd and cull out all sows that do not yield a certain percentage of pigs annually. Each sow should have at least twelve well-developed teats, thus providing for the proper nourishment of large litters.

The important qualifications of the market hog should be looked for,

namely, smoothly covered shoulders, a wide, straight, deeply fleshed back, well-sprung ribs, straight, deep sides, broad rumps, and deep, well-rounded hams. A broad, well-developed pelvic cavity will generally insure a sow easy in parturition. The body should stand on moderately short, straight legs, with a moderate amount of bone. All hogs, particularly breeding animals, should stand well up on the toes. There is a tendency, more marked in some breeds than in others, for the pasterns to break down, so that the animal walks on the pastern bone instead of on the toes. This is particularly the case with the hind pasterns and is oftener noticed in boars than in sows. It is a weakness that seriously impairs the usefulness of the animal.

Brood sows should, of course, show quality, but this should not become overrefined and delicate. Extremes of refinement usually lead to delicacy of constitution and often accompany sterility.

As a last but very important point, these first sows should be uniform in type. Uniformity of type goes far beneath the surface. It includes every part of the internal organization. The reproductive system, the digestive system, the circulatory system, and even the nervous system influence uniformity. The breeder may often be disappointed in his results from sows that he thought were of a uniform type. His pigs are a heterogeneous lot, unpleasing to the eye, unsatisfactory in the feed lot, and profitless to the pocket. In such a case a lack of uniformity in the powers of heredity may no doubt be assigned as the cause of these unfortunate results. It must be borne in mind that it is comparatively easy to select sows that are uniform in quality, constitution, and conformation. This may be done by any skillful judge of hogs. But our only basis for the selection of animals uniform in reproductive powers and heredity of type is the breeding record of their sires and dams and the standard of the herds from which they come. For this reason it is readily apparent why it is an advantage for the beginner to select his sows from one well-established herd. Whether the sows will be uniform in breeding powers can only be determined definitely by testing them in the herd, but to select them from the same herd or from herds of similar breeding will be a reasonable guaranty of good results. When a sow has shown herself to be a prolific breeder she should be retained as long as her reproductive powers are maintained.

Uniformity in a herd is the surest index to the worth of the stock and the skill of the breeder, and its advantages are obvious. A uniform lot of pigs will feed better, look better when fattened, and command a higher price on the market than a mixed lot. With a bunch of sows closely conforming to the same standard, whose reproductive powers are similar, uniform pigs may be expected.

The importance of the male in the herd should not be asserted at the expense of the females, yet the importance of a male of marked

excellence must not be minimized. The boar represents 50 per cent of the reproductive power of the herd concentrated in one animal; the sows represent an equal amount of reproductive force, divided up among ten or twenty or fifty individuals. If, then, these females do not in their conformation and fecundity conform strictly to the same type, they are merely convenient machines for the birth and rearing of young—not what they might be, an influential force in furthering the plans of the breeder and raising the standard of the herd. It is not proposed to discuss at length in these pages the operation of the forces of prepotency as varying factors in breeding operations. The relative influence of one parent over another, the swamping of a weakly organized female influence by a strongly prepotent male factor, or vice versa, are interesting and important, but belong to the special study of heredity.

SELECTING THE BOAR.

If there is a tendency at times to exalt unduly the influence of the boar and neglect that of the sows, the beginner should not permit himself to reverse things and entirely neglect the boar. It was, indeed, the feeling that any male could be used so long as he had sufficient strength for service that brought about arguments in favor of the value of the boar. A breeder can not afford to neglect the animals of either sex. The male has, perhaps, the greater influence on the herd, for the simple reason that every pig in the herd is sired by him, whereas they have not all the same dam. To achieve the best results a breeder should never allow the standard of his sows to be lowered, and should always couple them with a boar of a little better grade. One thing must not be forgotten, and it indicates the chief difference between the influence of the two sexes in the herd: A superior boar may be used on a herd of inferior sows with good results, but the use of an inferior boar on sows of high quality will have a disastrous outcome. The one method raises the standard of the herd; the other inevitably lowers it.

A boar with the male characteristics strongly developed should be selected, preferably as a yearling or else as a pig that had been purchased at the same time as the sows and allowed to come to maturity before using. He should have a strongly masculine head and a well-crested neck. His shoulders should be developed according to age; but strong shoulder development in pigs under a year or eighteen months is objectionable. The same indications of a good pork-producing carcass that the sows required should be seen in the boar—a broad, straight, deeply fleshed back, much depth and length of side, and well-developed hind quarters. The boar should be selected to correct any defects that may be common to the sows; for example, if the sows are rather coarse in bone and loosely built, the boar should have

high quality—fine bone, skin, and hair. If the sows tend toward over-refinement and delicacy, the boar should be rather "rangy" and strong-boned. There is a common belief that the male parent influences principally the extremities and general appearance of the offspring, while the vital organs (the heart, lungs, and viscera) resemble those of the female parent. This theory is strongly questioned by some modern authorities on heredity; but so long as our knowledge of the subject is so limited and this particular phase is in dispute, it can do no harm to select breeding animals according to the old ideas. The visible organs of the reproductive system should be well developed and clearly defined. A boar should not be bought with small, indefinitely placed testicles. Avoid particularly a boar with only one testicle visible.

The boar should stand up on his toes. There should not be the slightest indication of weakness in the pasterns of a young one; in a mature boar (2 or 3 years of age) that has seen hard service it may be expected that he will be a little down on his pasterns, but a 6 or 8 months old pig that does not carry himself on upright pasterns is not a safe animal to select for a herd boar; the hind pastern will be in much danger of breaking down with a little age and service. Look carefully to the set of the hind legs. The hock should be carefully set and straight. A crooked hock is as great a drawback as a weak pastern.

FEED AND MANAGEMENT.

The details of selection, feed, and management of live stock are intricately interwoven and interdependent. A man may be an excellent judge of stock, able to select those animals for his herd whose use will give the best results in breeding; but if his system of feeding and management is not such that the animals will thrive and yield a good increase, good selection is rendered ineffective. On the other hand, the herd may be carefully fed and skillfully managed, the feed may be the best and properly combined, the shelter warm and dry, and the water supply pure; but if the herd is poorly selected the owner is practically throwing away the feed he gives them.

THE SOWS.

Hogs require attention, regardless of condition, age, or sex, but the management of the brood sows is the surest test of the breeder's skill. If sows are carelessly fed during pregnancy, trouble of some kind is sure to ensue at farrowing; if overfed after farrowing, losses may occur among the pigs from scours and thumps. At no time is the development of the pigs so easily influenced as while they are dependent on the sow's milk—the first month of life. Excepting the ravages of epidemics, perhaps the greatest death losses in the herd occur dur-

ing this time, including farrowing. The accidents during farrowing, an attack of scours due to the milk of the dam, or a chill while following the sow in pasture on a wet day may stop growth temporarily, leaving a permanently stunted pig, or result fatally. On the other hand, the results of good management during pregnancy are as marked as the unfortunate consequences of careless methods.

Management during pregnancy.—It is assumed that sows that are bred are purchased as the foundation stock. If these sows are not all from the same herd they should not be placed together until they are all known to be free from vermin and contagious disease. They must be washed or dipped and quarantined from each other at least thirty days. If they come from the same herd no quarantine will be necessary.

It is always well for a purchaser to ascertain from the seller the details of management and feeding to which the animals were accustomed before changing owners. This system of feeding should be conformed to, or, if this is not possible, the old ration should be gradually replaced by the more convenient one, the time of transition being from ten days to two weeks. For the first few days newcomers should be fed lightly.

During pregnancy two facts must be borne in mind. The first is that the sow is doing double duty. Not only is she keeping up her own bodily functions, but the development of the fetal litter is a constantly increasing drain on her system. Although feeding at this time will not need to be so heavy as after the pigs are farrowed, it should be liberal. The sow's condition should be "good"—neither too fat nor too lean. An error which would allow the sow to become fat would perhaps be least productive of serious consequences. It is hardly too much to say that the mistakes in feeding breeding animals are more frequently those that keep such stock in a thin, half-starved condition, under the idea that the reproductive organs are so peculiarly liable to become transformed into masses of fat that the least appearance of fat on the animal's back and ribs will be the first step in bringing about such unfortunate circumstances. The use of the reproductive organs in either sex creates demands of an unusual nature on the animal organism, and these demands must be met in the same manner as those of a different character—such as growth, work, etc.—and that is by providing liberal supplies of the proper kinds of feed. It is beyond reason that a sow can give birth to a strong litter of pigs after having gone through a four months' fast. The importance of ample feeding of pregnant females, in the case of sheep, has been shown recently by Mumford[a] in Missouri. He found that during the first six to nine weeks of life those lambs having the

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[a] Bul. No. 53, Missouri Expt. Sta.

heaviest birth weight made the greatest gains. The records of the gains of the lambs after weaning were not tabulated. As the develment of the fetus is intimately associated with the nutrition of the dam, it is urged that "we can profitably pay more attention to the development of the unborn lamb." Whether a similar fact may be true in the case of hogs is yet to be shown. It may not be unwise to assume that it may be so. Bad results undoubtedly may be brought about by overfeeding, especially as sows are naturally indolent and loath to exercise, but a counteracting influence will be found in ample exercise that may be provided by a large pasture or even by driving slowly a mile or two each day. The necessity of exercise must not under any circumstances be overlooked.

It must be remembered, in the second place, that the main demands upon the sow are those for the building of new tissue. Hence the kind of feed is important. The amount of nitrogenous, or protein-bearing, feeds in the ration at this time should be increased. These are bran, pease, beans, oats, and barley, and, to a moderate extent, wheat. The forage plants that are especially suitable to pregnant brood sows are the clovers and their relatives—alfalfa, peas, beans, vetches, etc. The ordinary pasture grasses are also of much value. Feed should be given in such form that the system of the sow will be at its best. All breeders lay special emphasis on the condition of the bowels during pregnancy, and particularly at farrowing, the special danger to be avoided being constipation. To this end the greater part, if not all, of the grain ration is given as slop, and toward the close of the period of gestation oil meal or a small amount of flaxseed meal is introduced into the ration.

Corn should not be fed in large amounts to breeding stock. If possible, it should not be fed at all to any but fattening animals. In the corn belt many farmers are often so situated that they have no other grain feed at hand. If corn must make up the greater part of the ration of the brood sow, the injurious effects may be counteracted in a measure by compelling the sows to exercise. Various schemes may be necessary to bring about this result, such as having the house and feeding floor or the feeding floor and watering place at opposite ends of the hog lot; so that a good walk is a necessity several times each day. If the lot is located on a hillside, the walk is made a climb. Some men scatter grain among straw and corn fodder with this idea of exercise in mind, and others resort to the whip and drive the sows gently for a mile or two each day.

During the winter more care will be needed to keep the sow in good health on account of the absence of pasture. Not only does the hog's system crave green feed, but more or less bulk is demanded. This is especially needed when a considerable amount of confinement is necessary. To offset the lack of green feed nothing surpasses roots.

These may be sliced or pulped and mixed with the grain or may be given whole, as a noon feed. Some care must be used in feeding roots, as they are laxative in effect, and if fed in excessive amounts may bring about profuse action of the bowels. Some Eastern farmers recommend the use of silage. If neither is available, clover or alfalfa hay, sheaf oats, or corn fodder may supply the bulky requirement of the ration with good results. Charcoal, ashes, and salt should be accessible at all times. These act as a vermifuge and preventive of disease and meet the hog's craving for mineral matter in the feed. The Bureau of Animal Industry formula is found on another page in this bulletin. (See p. 37.) The constant use of such a preparation with a varied and not too carbonaceous ration and care in removing the afterbirth will, in large measure, prevent sows from eating their pigs at farrowing time. During the entire period care should be taken to keep the system well toned. The sow should become accustomed to being handled, and should look upon her attendant as a friend.

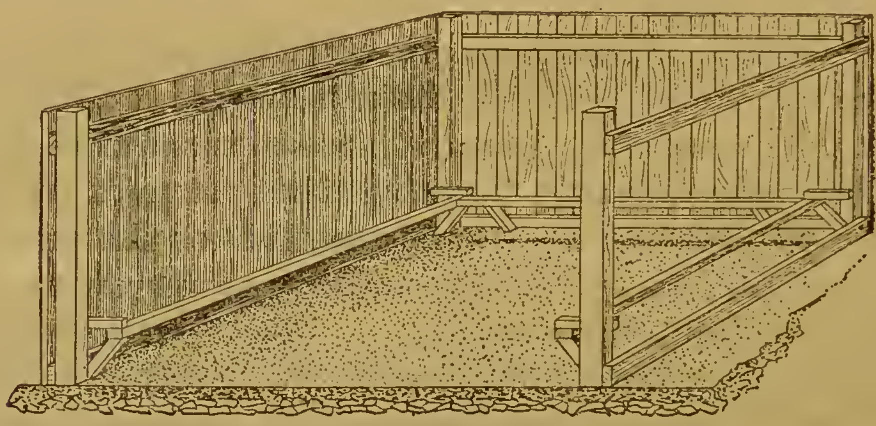

FIG. 19.—Farrowing pen with fenders.

All the brood sows may run together up to within two weeks of farrowing time; then it is well to separate them, placing each sow by herself in a yard with a small house, such as has been described, which should be dry, airy, and clean. A great deal of exercise will not now be necessary. The feed should be reduced somewhat, and if there is any tendency to constipation a slight change of feed may be necessary. If individual houses are not available, sows can not be separated until near farrowing time.

The farrowing pen should be provided with fenders around at least three sides about 6 or 8 inches from the floor and 6 or 8 inches from the wall. These should be strong enough to support the weight of the sow should she lie on them. They will, to a great extent, protect the pigs from being lain upon during the first few days of their lives. This will go far to prevent a very fruitful cause of loss among young pigs. The little fellows will soon learn to creep under these fenders when the sow lies down. Figure 19 shows a farrowing pen with fenders made of 2 by 4 scantling fastened around the walls.

Many breeders now use a specially arranged farrowing pen for sows, the object being to allow the sow room enough to farrow with reasonable comfort, but not enough to turn around. The safety of the pigs under such circumstances is said to be much greater than when the sow is given all the space she cares to take. Provision is made for the safety of the pigs by raising the walls of the pen 6 or 8 inches from the floor. Such a pen may be readily arranged by placing the sow at one end of her pen and nailing boards across so that she can not turn, leaving space for the pigs to slip under the barrier. A number of patented farrowing pens are on the market.

Farrowing time.—Sows vary little in the period of gestation. This period is about one hundred and twelve days from the date of breeding. This date should be known, to avoid mistakes that may result in loss of pigs. As the time for farrowing approaches the sow should be watched carefully, in order that assistance may be given, if necessary. If she has already farrowed a litter, and has been properly fed and cared for during pregnancy, little difficulty may be expected. With young sows, particularly those bred at an immature age, there is a considerable element of risk at this time not only to the pigs, but to the sow herself.

The bedding of a sow at farrowing time should be sufficient only for cleanliness and dryness. If furnished in large amount, the pigs will burrow into it and get lost or be crushed. The best bedding is rye straw and wheat straw, and if the straw is cut it makes an almost ideal bed. Chaff is excellent if it can be obtained. Oat straw is not so valuable.

The management of sows during farrowing will depend largely on the animal and on the weather conditions. Assistance should be at hand if needed, but the sow should not be helped if she is getting along nicely alone. Many pigs are lost annually by lack of attention during farrowing; but, on the other hand, there is no doubt that in many cases overanxiety and too much attention may do more harm than good and often result seriously. The assistance that is imperative at this time is to help in cases of difficult labor and to protect pigs from chilling in cold weather. The temperament of the sow should be considered; some are plainly annoyed by the presence of an attendant and show it in their nervous actions; others may be positively ill natured and resent interference. Such sows are better left alone during farrowing, and should be bred to farrow when warm weather may be expected, so that the chances are as much in favor of the pigs as possible. If the sow's nervousness or ill nature leads her to eat her pigs, the best remedy is to put her in the pork barrel at the earliest opportunity.

When farrowing occurs during warm weather, a minimum amount

of attention will be needed. The pigs are less likely to become chilled at this season and will generally find their way to the teats unaided. Proper preliminary feeding of the sow and good quarters will make the chance of trouble small. On the other hand, if a sow farrows during extremely cold weather the pigs will be in danger of being chilled unless the house is heated. To remedy this some breeders throw a blanket over the sow until she is through. Others place a few hot bricks or a soapstone in the bottom of a basket or barrel, covering them with straw, and put a cloth over the top to prevent too rapid radiation; and, unless the sow objects too seriously, the pigs are placed in this receptacle as fast as they arrive. They will not suffer if they do not suck for a few minutes, and they will be dry and warm when placed to the teats. This treatment will be necessary even in warm weather with sows that are nervous and move about during farrowing. When farrowing is over the pigs should all be placed to the teats, care being taken that each one gets his share. When the afterbirth is passed it should be removed at once and burned or buried. There is good reason to believe that the eating of the afterbirth is often the beginning of the habit of eating the pigs that is so troublesome with some sows.

In very cold weather it may be necessary for a few days to remove the pigs to a warm place after they have sucked, to prevent chilling. As newborn pigs suckle as often as every two hours during the day, this entails considerable inconvenience; but it is time well spent and may mean the difference between profit and loss to the breeder. The pigs are soon able to fight their battles with the cold unaided by any but their own warmth and that of the dam.

For the first twenty-four hours the sow should, as a rule, have no feed, and will need none. If, however, she shows signs of hunger, a thin slop of bran and shorts or a thin oatmeal gruel may be given. Tepid water should be given to drink as the sow wants it. Never give cold water.

The feeding for the first three or four days should be light and carefully given, and the time consumed in getting the sow on full feed should be from a week to ten days, depending on the size and thrift of the litter. The first feed should be very light, and in the form of a thin, warm slop, such as is mentioned in the preceding paragraph, working gradually to full feed. The pen should be cleaned daily if the sow is confined to it.

THE SOW AS A MOTHER.

No time should be lost after farrowing in getting the sow into the open air. Of course, if the pigs were farrowed during the winter months care will be needed, and it may be necessary to let the pigs reach the age of two weeks before turning them out. They can, how-

ever, get considerable exercise in the piggery or in the lot with the sow, and there is often a lot adjoining a barn that is sunny and sheltered from cold winds where the new family may be turned for exercise. Avoid particularly allowing the pigs to run out during a cold rain. They are especially tender during the first weeks.

The appetite for something besides the dam's milk may begin to assert itself by the time the pigs reach three weeks of age. This time will vary, of course, some pigs being more precocious than others. They will be noticed nibbling at grass, rooting a little, and even investigating the sow's feed. A pen should be arranged adjoining that of the dam and separated from it by a partition, with sufficient room at the bottom to allow the pigs to run under. Figure 20 shows a pen arranged with the partition between it and the dam's pen raised. In this inclosure put a low, shallow trough and place in it a little skim milk or a thin gruel similar to that recommended for the sow the first day after farrowing. This gruel may be made with any concen-

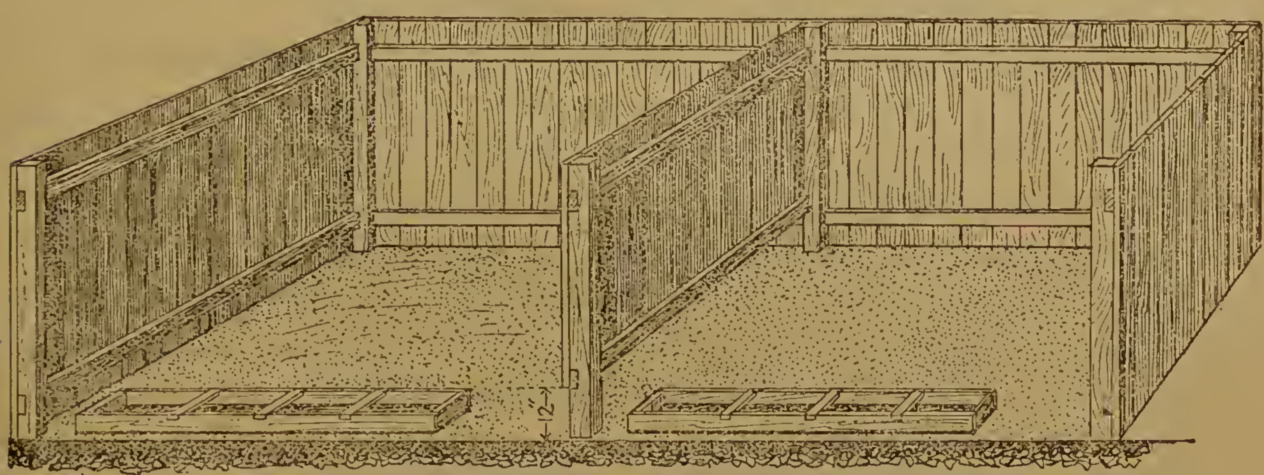

FIG. 20.—Double pen for feeding suckling pigs; partition raised to permit pigs to run to their feed without interference from the sow.

trate that is free from woody matter. If ground barley or oats is fed, the meal should be first sifted to remove the hulls. There is a great variety of feeding stuffs that can be used. The main point to be observed is that the pig's stomach is very easily deranged at this age and feeds must be given that will digest readily. The trough in which the pigs are fed should be kept clean. No stale feed should be allowed to remain in it from one feed to the next.

As the pigs learn to eat the feed may be increased. Skim milk should be used liberally, using rather large quantities at first, from 6 to 12 pounds of milk to each pound of grain. During this period comparatively little corn should be fed, as a rule. More growth can be obtained with a narrow ration, and the corn should be withheld until the fattening period comes. The pigs should be kept growing constantly, and the best results will come with feeding a little under their capacity rather than all they can consume. To counteract the tendency to become too fat they should have plenty of exercise.

Scours and thumps often cause very serious losses among young pigs. The former is caused usually by overfeeding, by feeding badly spoiled feed, by an abrupt change of feed, or by a change in the feed of the dam that affects her milk. Thumps is generally caused by overfeeding and lack of exercise.

WEANING.

If the pigs have been properly managed for the month after they first begin to eat, and are taking feed in amounts sufficient to make them more or less independent of the sow's milk, weaning will not be a difficult process, and will be brought about so that it will be scarcely perceptible, so far as the effects on the pigs are concerned. The time to wean will depend on the way the pigs are eating and the convenience of the breeder. If they are not thoroughly accustomed to a grain and skim-milk ration the time must be delayed, and if there is no occasion for breeding the sow no harm is done by allowing the pigs to run with her to the age of twelve weeks or older.

Breeders differ widely as to the age of weaning. The majority wean at six to ten weeks, with a considerable number at twelve weeks; some older than twelve weeks and a few younger than six weeks. The breeders who wean at the early periods usually are situated where dairy by-products are plentiful, and they usually raise two litters each year, making the demands of the pigs on the sow as brief and light as possible. Breeders in the corn belt wean at the more mature ages, rarely weaning as young as six weeks, and often allowing the pigs to reach the age of sixteen weeks before the sow is taken away. A considerable number of men make no attempt to wean, as the word is generally used; that is, there is no enforced separation of the sow from her pigs; the pigs run with the sow until her instinct tells her that they are old enough to shift for themselves.

The method of weaning will depend somewhat on circumstances. If the pigs are so little dependent on the sow's milk that she is gaining rapidly in flesh and lessening in milk flow the weaning may be abrupt, the sow being taken away out of hearing. If she is still milking considerably she may be returned to the pigs once a day for two or three days, or the pigs may be taken away in detachments, beginning with two or three of the largest and strongest, then the next strongest, leaving the weakest ones of the litter to complete the drying off.

Whether the weaning is brought about directly or gradually, it should in all cases be complete and decisive. The pigs should be placed apart from the sows in quarters secure enough to prevent communication. By no means should pigs be allowed to follow a sow until she is almost worn-out. The pigs are no better and the sow infinitely worse than if weaning had been brought about properly.

FEEDING THE PIGS.

Attention will now be given to the pigs that have been weaned. Up to this time all are on the same feed and under the same management. From now on, however, those that are to be retained as breeding animals should be continued on a growing ration—that is, one which is somewhat narrow and will develop bone and muscle to the largest extent. Those that are to be fattened for market should be fed more liberally and their feed made more carbonaceous.

THE BREEDING STOCK.

The foundation on which to build up a successful breeding animal is ample range, affording an abundance of exercise, and a rather narrow ration. Growth should he continuous and feed plentiful. The pigs should not be given range so large and so little feed that they will develop nothing but bone; neither should they have so much to eat that they will become indolent and refuse to take the exercise required to develop necessary bone and muscle. Exercise will strengthen the sinews and develop strong muscles, as well as firm joints and strong legs, while a well-filled stomach will nourish these; and from this management we may expect a sow that will be strong, thrifty, and a good breeder, and a boar that will do good work in the herd without breaking down in any respect before he should.

Gilts should not be served before the age of eight months, bringing the first litter at twelve months. This gives sufficient time for the development of the reproductive organs.

SELECTING FOR FATTENING.

As soon as it is determined what pigs are to be fed for market their fattening should be started without delay. Experiments have repeatedly proved that young animals always fatten more economically than old ones, and therefore any delay in finishing is accompanied with a loss. In rare instances it may pay to keep a pig over winter as a "store" hog, but generally he loses the flesh he accumulated while suckling his dam, and this can not be replaced except at increased expense. Corn will now come into the ration, and should be supplemented by all the variety of feed at the feeder's command, to keep the appetite keen and the digestive system in the best condition. This variety should consist of mill feeds, dairy by-products, and succulent feeds, and, according to some authorities, pasture. If skim milk, whey, and buttermilk are at command they can be combined to very good advantage with the ration, commencing with a proportion of about 2 pounds of milk to 1 of grain at weaning time, and reducing the quantity of milk until the pigs are finished on grain alone. A pig gives best returns from dairy by-products while young. The fattening pigs should gain from 1 pound to 1½ pounds daily, and should weigh

between 250 and 300 pounds at 9 or 10 months of age. Gains made after this weight are nearly twice as expensive as those made when weighing from 50 to 100 pounds, and a well-bred pig finished at a weight of about 250 pounds will very nearly fill the market requirements and bring a satisfactory price.

SELECTION OF BREEDING STOCK.

The pigs which are to be used for breeding purposes should be selected during the time when the pigs are with the sow. If he is raising hogs for market a breeder will select only sows, castrating all boars. No boar should be used or sold that is not eligible to registry. If the breeder is raising purebred stock the inferior boars will be culled out and castrated, the others being kept for the breeding market.

The selections should be made as early as possible, depending on the skill of the breeder. That noted feeder, the late Mr. William Watson, used to select his show lambs and calves not later than three days of age. He said an animal had all the development of heart and rib at that age that he would ever get, and his results in the show ring bear out the accuracy of his judgment. However, all are not endowed with the keen insight into animal form that Watson possessed. A selection for a breeding animal should not be made unless there are good and sufficient reasons for it, and unless the breeder is quite sure he is right in making the selection. The sows selected should be from large litters and from dams that are good milkers, and of quiet, motherly dispositions.

CASTRATING AND SPAYING.

The boar pigs should be castrated during cool weather, as soon as the testicles descend into the scrotum. An early date is always preferable to a late one, for the development of sex characteristics is of no value to an animal that is intended for meat.

The practice of spaying sows is not very general. It is much more difficult than castration. It often happens that sows may become pregnant before spaying and bear a good litter of pigs after that operation.

MANAGEMENT OF THE DRY SOWS.

After the pigs are weaned the dry sows should be placed in a pasture by themselves and given very little grain. Those that show themselves to be prolific and good mothers should be retained as breeders; those having a deficient breeding record or being unsatisfactory in any way should be fattened and sold as soon as possible. It does not pay to keep over a year a sow that can not raise a large litter, unless she is purebred and a very exceptional individual.

If a second litter is wanted during a year the sows should be put to

the boar during the first heat after weaning. Many breeders do not like to pass many periods of heat for fear that the sows may become "shy," and there is little reason why the sow should not have two litters a year. In any case, the sows should be carried on comparatively light feed until time to breed again, gaining a little in weight; and their treatment after breeding should be as already detailed for pregnant sows.

The use of a breeding crate (fig. 21) is growing in popularity. When a small sow is to be bred to a large, heavy boar it is almost a necessity; its use prevents injury to the sow. Some sows, although in heat, will not take the boar readily, and the use of a crate in these cases insures a successful service. Many breeders use a crate for all their sows.

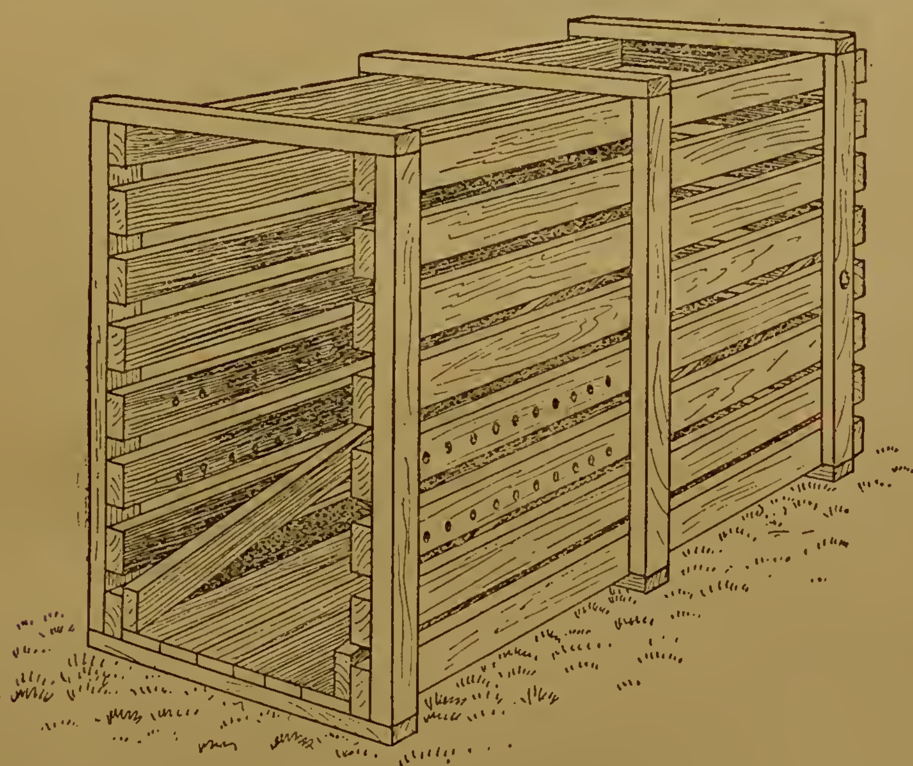

Fig. 21.—Breeding crate.

Such an appliance may be made by any carpenter. All that is necessary is a stout frame, made of 2 by 4 inch scantlings, closed in front but open behind, a bar to slip behind the sow just above the hocks, and a 2 by 4 inch strip attached at the forward end of the crate on either side, about the position of the sow's head and extending to the rear of the crate, where it is fastened to the bottom of the crate. The boar's fore feet will rest on these strips.

MANAGEMENT OF THE BOAR.

The management of the boar has been left until this place in the discussion, not because it is an unimportant subject, but because the sows occupy by far the greatest amount of the breeder's attention; and also because it was assumed at the outset of this discussion that the work of a beginner, with only a group of brood sows, was being outlined.

When the boar arrives at the farm he should be dipped, as a matter of ordinary precaution, against the introduction of vermin. As an additional precaution, a quarantine pen should be ready for him, especially if epidemics are prevalent. In short, he should be treated in much the same manner as has been prescribed for the sows. His feed before change of owners should be known, and either adhered to or changed gradually to suit the new conditions. If he shall have come a long journey it will be well to feed lightly until he is well acclimated.

His permanent quarters should be a clean, dry, warm, well-lighted, and well-ventilated pen, 10 or 12 feet square, with a yard adjoining where sows may be brought for service. This yard should be large enough to give him some exercise during the breeding season, when it may be inconvenient to allow him the run of a pasture. Adjoining the yard should be the boar's pasture, from one-half acre to an acre in extent, consisting of clover, alfalfa, or good pasture grasses that thrive in the locality.

Breeders generally advocate the practice of keeping a boar to himself during the entire year—out of sight and hearing of the sows. However, a boar is often allowed to run with the sows after they are safe in pig; but during the breeding season it is by far the best policy to keep him by himself, admitting a sow to his yard for mating, and allowing but one service. This will be productive of the best results in many ways. The energies of the male are not overtaxed. He may thus serve a much larger number of sows, and the litters will generally be larger and the pigs stronger. In the case of a sow that is a somewhat shy breeder and a valuable animal she may be allowed to remain with a boar during the greater part of her heat, but such instances are exceptional. Another advantage of the single-service system is that a man always has an accurate knowledge of his breeding operations and knows when to expect farrowing time.

The feed of the boar when not in service may be of a succulent nature—mainly pasture and cut green forage during the summer months and roots in winter. A boar can hardly be sustained on this alone, and some grain should be allowed to keep him in condition. This should be nitrogenous in character, consisting of mill feeds—such as shorts, middlings, and bran—some oil meal, and the leguminous grains, with a little corn. As the breeding season approaches the feed should be increased, so that the boar will be in good condition. While not in service ample exercise should always be insisted upon, even if it must be urged by the whip. Exercise is productive of well-developed muscles and general thrift; with these two conditions activity and soundness of reproductive organs will usually follow. During the breeding season it will not be possible for the boar to get the same amount of exercise, and accordingly care must be taken that his energies are not wasted by unnecessary service. Care-

ful feeding will do much to counteract this disadvantage. It must always be remembered that the drains on a boar during service are severe, especially if 50 or 60 sows are served. This will require ample feed, with as much exercise as possible, and, with care in his treatment, will bring about good results. A fully matured boar should not serve more than 2 sows daily, preferably one in the morning and one in the afternoon, and can serve 50 or 60 in a season without difficulty.

Coburn[a] advises that where farmers own but 12 or 15 sows each, three or four breeders might purchase a boar and use him in common, thus saving materially in expense. Cownie[b] states that he has found it well to have at least two boars in the herd, even though the herd be small in numbers.

SANITATION IN THE HOG LOT.

The greatest drawback to the hog industry which breeders in this country have to contend against is the presence of highly contagious diseases known as "hog cholera" and "swine plague," or, popularly, as "cholera," and were it not for the fecundity of these animals their profitable production would be out of the question. These two diseases are so closely identical that postmortem examinations are usually required to distinguish between them. Indeed, only recently (on October 1, 1903) de Schweinitz and Dorset, of the Bureau of Animal Industry, announced the discovery of a fatal disease of swine which is caused neither by the hog-cholera nor swine-plague bacilli, and which is apparently a very frequent cause of swine fatalities.

For the present the breeder can regard these diseases as identical, so far as his practical management of the herd is concerned.

There are a few fundamental facts which he must remember if he is to avoid losses by reason of the presence of hog cholera or swine plague in the herd. The first is that they are specific germ diseases, disseminated by bacteria, and the contagion can not be spread from one animal to another or from one herd to another except by these minute organisms. They may be carried in a multitude of ways—by the hogs themselves, on the clothing of persons, on vehicles, in feed, by dogs, birds, and other animals, or by streams. The breeding or feed of a hog can not cause either disease, although bad methods may so weaken constitution and vitality that the animal becomes more susceptible than would otherwise be the case. Second, diseases caused by bacteria may be prevented in large part by thorough disinfection. Third, bacteria are generally preserved in filth, and, therefore, scrupulous cleanliness will go far toward preventing outbreaks of disease in herds of hogs.

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[a] Swine Husbandry, pp. 93, 94.

[b] Kansas State Board of Agriculture, Thirteenth Biennial Report, p. 693.

PREVENTION OF DISEASE.

Cleanliness.—Preventive measures must be most relied upon. Hogs must be given dry and well-ventilated quarters, which must be kept clean. Contrary to common belief, hogs have some habits which raise them above other domestic animals from the standpoint of cleanliness. For example, unless compelled to do so, a hog will not sleep in its own filth. If part of the floor of the pen is raised and kept well bedded with straw, while the rest is not, all excrement will be left on the unbedded portion of the floor, and the bed itself will always be clean.

Feeding and drinking places should be clean and the water supply pure. Unless the origin is known to be uncontaminated and there has been no possibility of infection during the course, hogs should not be allowed access to streams. Wallows should be kept filled up as much as possible. At least once a month the quarters should be disinfected with air-slaked lime or a 5 per cent solution of crude carbolic acid. If a hog dies from any cause, the carcass should be burned or buried and the pens thoroughly disinfected at once.

Breeding and feeding.—While inbreeding is the surest and quickest means to fix type, the system weakens vitality unless very carefully followed. For this reason closely inbred hogs are more susceptible to cholera than those whose constitutions have not been impaired by the system. The straight corn diet which many hogs receive from one year's end to the other also lessens vitality, and the researches of the Wisconsin Experiment Station have shown that this is probably brought about by actually retarding the development of the vital organs. A minimum of inbreeding and a varied diet, including, especially for breeding stock, ample range, will therefore better enable the herd to resist the attacks of disease.

Isolated houses.—The advantage of a number of small portable houses, each accommodating a few hogs, rather than one large piggery for the entire herd, has been referred to in the foregoing pages. In districts where cholera is prevalent these are undoubtedly the best shelters. They make it more difficult to carry contagion to all animals in the herd, and the destruction of one of them in case of an outbreak does not entail a great expense. An added advantage is that they may be moved from place to place as needed. While more work is necessary in feeding, the convenience and safety from their use more than offsets this disadvantage.

Quarantine.—Whenever new animals are brought to the farm, or when animals are brought home from shows or from neighboring herds, they should be kept apart from the rest of the herd for at least three weeks. If they have been exposed, the disease will manifest itself within this time, and the sick animals can be treated or killed and disposed of at once.

If cholera breaks out in the neighborhood the farmer should maintain a strict quarantine against the infected herds. He should refrain from visits to farms where they are located, and should insist on his neighbors staying out of his hog lots. Intercourse of all kinds at this time should be carefully restricted. The contagion is so easily carried that the strictest measures are justifiable.

TREATMENT OF DISEASES.

As soon as sickness appears in the herd the unaffected hogs should at once be removed to clean, disinfected quarters, preferably without much range, for by running over pastures they may come in contact with contagion. Their feed should be carefully regulated, and, if they have previously been on pasture, should include some green feed, roots, or an abundance of skim milk.

The quarters in which the sickness first appeared should be thoroughly cleaned, all bedding and rubbish burned, and loose boards and old partitions torn out and burned. If the pen is old, knock it to pieces and burn it. Disinfect pens and sleeping places, using air-slaked lime on the floors and the carbolic-acid solution on the walls and ceilings. Whitewash everything. If a hog dies, burn the carcass or bury it deeply out of the reach of crows, buzzards, or dogs. If possible, do not move the carcass from the place where it falls; but if this can not be done the ground over which it is dragged should be disinfected. Hog-cholera bacilli can live in the ground for at least three months. Care must be taken to maintain an absolute quarantine between the sick and well hogs. The same attendant should not care for both lots unless he disinfects himself thoroughly after each visit to the infected hogs. Dogs should be confined until the disease is stamped out.

Treatment of hogs suffering from cholera or swine plague is not always satisfactory. The disease runs its course so rapidly that curative measures are more or less ineffectual, and prevention of an outbreak should be relied upon rather than the cure of sick animals. Salmon[a] states that the following formula has been successful when properly administered in less virulent outbreaks as soon as signs of sickness are shown:

	Pounds.
Wood charcoal	1
Sulphur	1
Sodium chlorid	2
Sodium bicarbonate	2
Sodium hyposulphite	2
Sodium sulphate	1
Antimony sulphid (black antimony)	1

[a] Farmers' Bul. No. 24, Dept. Agr.

"These ingredients should be completely pulverized and thoroughly mixed. In case there is profuse diarrhea the sulphate of sodium may be omitted."[a]

A large tablespoonful once a day for each 200 pounds of live weight of hogs to be treated is a dose. The medicine should be thoroughly mixed with the feed, which should be soft, made of bran and middlings, corn meal and middlings, corn meal and ground and sifted oats, or crushed wheat, mixed with hot water. If the hogs are too sick to come to the feed, they should be drenched by pulling the cheek away from the teeth and pouring the medicine in slowly. Care should be exercised, as hogs are easily suffocated by drenching. Do not turn a hog on its back to drench it.[b]

PREVENTION AND DESTRUCTION OF VERMIN.

Hogs often suffer very much from vermin. Lice are introduced from neighboring herds, and the losses in feeding are often severe, especially among young pigs, when death is sometimes a secondary if not an immediate result. When very numerous, lice are a very serious drain on vitality, fattening is prevented, and in case of exposure to disease the lousy hogs are much more liable to contract and succumb to it.

Vermin are most common around the ears, inside the legs, and in the folds of the skin on the jowl, sides, and flanks. In light and isolated cases they may be destroyed by washing the hogs. In severe cases, however, especially where the whole herd is affected, thorough spraying or dipping should be resorted to. In this case a dipping tank will be a great convenience.

Figure 22 shows the ground plan and side elevation of the pig-dipping plant suggested by the Nebraska Experiment Station.[c] The details of construction may be understood from the drawings. The approach from the yard to the slide is cleated and elevated, at the inner end, 1 foot 6 inches above the ground. The slide is covered with zinc or galvanized iron, and with this pitch is very slippery when wet. The zinc which covers the slide is lipped over the edge of the tank to prevent waste of the dip. The tank is placed in the ground with its edges even with the surface. A galvanized tank is suggested; it can be easily made by a tinner. The size of the tank will depend on the number of hogs to be dipped. The one in the drawing is 4 feet deep, 10 feet long at the top, 5 feet long at the bottom, 20 inches wide at the top, and 8 inches wide at the bottom. The sloping surface of the tank should be cleated or fluted to enable the hogs to get out easily. The dripping pen is raised 1 foot 6 inches at the outer end and is cleated. The cleats are laid at an angle with the sides of the pen and arranged in pairs, with a space

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[a] Farmers' Bul. No. 24, Dept. Agr. [b] Idem. [c] Bul. No. 74.

between them so that the dip may drain back into the tank. Provision must be made for the displacement of fluid by means of tongued-and-grooved boards fastened to the sides of the vat.

One of the most effective and cheapest preparations to use as a dip is a 2 per cent solution of creolin. The common tobacco dips used for sheep scab are also efficacious. If the hogs are washed, apply the solution with a broom; if they are sprayed, use an ordinary spray pump; for dipping, use a dipping tank. When being washed or sprayed the hogs should stand on a tight board floor.

Newly purchased hogs should be carefully examined for vermin, and they should not be turned with the herd until they are known to be free from these pests.

When the herd is found to be badly infested with lice all bedding should be burned and loose floors and partitions torn out. Old boards and rubbish should be burned. The quarters should then be

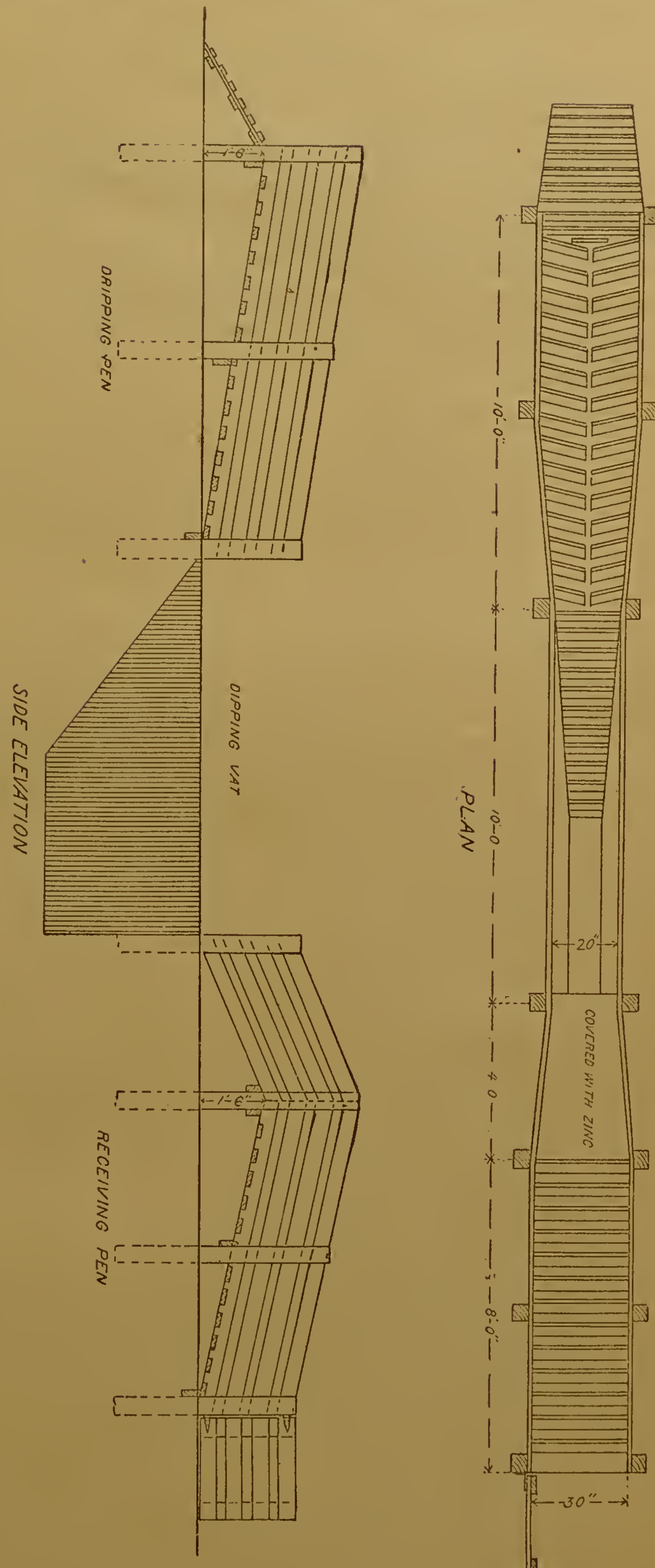

Fig. 22.—Dipping plant.

thoroughly disinfected by spraying with one of the solutions mentioned. (The creolin solution is good.) After disinfection, as in the case of a disease outbreak, everything about the place, inside and out, should be thoroughly whitewashed.

In these remarks on sanitation no attempt has been made to go into the details of the diseases affecting hogs or their treatment. They are simply intended to call attention to the simple measures which may be used by any farmer to avoid, to a large extent, the decimation of his herd by epidemics. Cleanliness and rational methods of management are relied upon by thousands of farmers to keep their herds in health and vigor. They are the marks of the good farmer and successful hog breeder.

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PURDUE UNIVERSITY.

Indiana Agricultural Experiment Station.

C. S. PLUMB, Director.

LaFayette, Ind., Bulletin No. 82, Vol. X, March, 1900.

Roots and Other Succulent Food for Swine.

BY C. S. PLUMB.

Succulent food is usually fed to swine in the central west, but mainly as a summer pasture. The fact that farmers turn their pigs on clover pasture, and have continued the practice is in itself evidence that the method has merit. Observing breeders realize that pigs so handled in summer are healthier and require less grain for profitable growth, than do those kept up and not given pasture. In winter, however, but few farmers feed succulent food to their pigs, the great majority relying on corn, with perhaps some shorts or bran in addition. It is fair to assume, however, that if the succulent food is beneficial in summer profitable returns should be derived from the use of such a material in winter. In as much as some of our most successful pig breeders do feed roots in winter, it is probable that they view their use with favor.

The use of succulent food for pigs has been the subject of investigation at the Indiana Station for some years, and pigs have been fed mangels, sugar beets, artichokes, rape and wild lettuce with the view of ascertaining their value as pig foods and their influence on growth. In June, 1899, the Station published a bulletin (1) on roots as food for pigs, in which a specific report was made upon feeding 12 Chester White pigs in an experiment, in which mangels formed a part of the rations for six of the pigs, the other six re-

(1) No. 79. June, 1899, Roots as food for pigs. By C. S. Plumb and H. E. VanNorman.

ceiving only grain food. The following figures, taken from the report of this work show in compact space the results from feeding the 12 pigs from Feb. 1 to April 19.

	Lot I. Fed mangels.	Lot II. Fed grain only.
Cost of food fed	$10.19	$12.05
Total pounds gain made	355.5	442.5
Average daily gain made in pounds	4.6	5.7
Lbs. of meal and shorts to make lb. gain	3.71	3.71
Cost food for each pound gain	2.8 cts.	2.7cts.

The pigs in this experiment made very satisfactory gains in both lots, yielding a good profit on the feeding, but so far as gains went, they slightly favored those not fed roots.

Mangels, however, are not so desirable a food as sugar beets, as they are less nutritious, sugary and tender. The great advantage in growing mangels, lies in the large yield per acre. Sugar beets, however, are relished by all farm animals, and to a greater extent than are mangels, and especially so by pigs. The agitation of growing beets for sugar, has also in localities drawn attention to their value as a food for stock, and has caused some farmers to feed them to their pigs. The favorable comments from such feeding, led the writer to introduce feeding some sugar beets at this Station to pigs experimentally, under the care of Mr. H. E. VanNorman, the writer's assistant.

Feeding Sugar Beets.

Eight pure bred Chester White pigs were used in this experiment, seven of which were farrowed on July 24 and one (No. 266) on June 10, 1899. These pigs were grouped into two lots of four each. Each lot was fed the same grain food, consisting of one part pure corn meal and two parts shorts, fed as a slightly warmed slop. Of two lots, lot I was fed cut up sugar beets in the slop. No liquid was fed excepting water.

This experiment began on Nov. 8, 1899, and closed on Feb. 14, 1900, extending over a period of 98 days. The pigs were each weighed at about the same time in the day, once a week, and the feeding was consequently divided up into feeding periods of seven days each.

The following table shows the weight of each pig on Nov. 8, and the subsequent weights.

Weights of Pigs in Pounds.

1899 1900	Lot I. Fed sugar beets.					Lot II. Fed no beets.				
Date.	No. 269	No. 271	No. 272	No. 273	Total wt.	No. 266	No. 267	No. 268	No. 270	Total wt.
Nov. 8	65.5	55.5	64.	53.5	238.5	73.	54.5	50.	61.	238.5
Nov. 15	64.	54.5	66.5	57.5	242.5	80.	61.	51.5	63.	255.5
Nov. 22	70.	60.	73.	64.5	267.5	87.	68.	57.	68.5	280.5
Nov. 29	72.	66.	80.	72.	290.	95.	74.	63.5	71.5	304.
Dec. 6	81.	70.	85.	77.	313.	103.	81.	70.	77.	331.
Dec. 13	86.	74.	88.	86.	334.	111.	87.	76.	81.	355.
Dec. 20	93.	78.5	93.5	91.5	356.5	126.5	100.	89.	92.	407.5
Dec. 27	100.	85.5	99.5	100.	385.	134.5	104.5	95.	96.5	430.5
Jan. 3	109.	90.	105.	104.5	408.5	143.	111.	101.	104.	459.
Jan. 10	119.	98.	114.	118.	449.	150.5	119.	112.	110.	491.5
Jan. 17	128.5	108.	123.	123.	482.5	169.	128.	119.	120.	536.
Jan. 24	136.	112.	131.	133.	512.	181.	141.	131.	132.	585.
Jan. 31	154.	122.	144.	145.	565.	189.5	154.	144.5	144.	632.
Feb. 7	159.	127.	151.	159.	596.	187.	162.	157.5	148.	654.5
Feb. 14	164.	135.5.	157.	164.	620.5	208.	161.	167.	146.	682.
Total gain	98.5	80.	93.	110.5	382.	135.	106.5	117.	85.	443.5
Av. daily gain	1.0	.81	.94	1.12	3.89	1.37	1.08	1.19	.86	4.52

An examination of this table shows that each lot weighed the same, viz: 238½ pounds, when the experiment began. That the pigs were in good condition physically is evident from the fact that eight of them made an average gain of slightly over a pound per day each during the experiment, which was very satisfactory, when one considers that they were fed during the coldest months of the year.

The pigs were fed in warm pens in the new Station feeding house, a description of which is given in the 12th annual report of the Station. They, however, did not sleep in the same pens in which fed.

The pigs in lot I, fed beets, did not grow as well as those in II, and the smallest gaining pig was in this lot, while the greatest growing pig was in lot II, as was the oldest pig of the eight. After the first week, however, it is interesting to note that every pig in each lot made constant gains, excepting Nos. 266 and 267, each of which fell off very slightly, at one weighing, towards the last of the experiment.

During the 98 days lot I, fed beets, gained 382 pounds, or a daily average of 3.89 pounds, while lot II gained 443.5 pounds, or a daily average of 4. 52 pounds. Two of the pigs in lot II made better gains than the two best grown in lot I.

Foods fed. The pigs were fed twice daily, at regular intervals in the morning and late afternoon. The plan was to allow roots to supplant the grain food in lot I as fully as possible, and still keep up a vigorous growth. Generally speaking, changes in the amounts of food fed were usually made at the beginning of a new feeding period, which began with the afternoon feeding.

The following table shows the amount of food consumed by each lot during the different weekly periods.

Total food eaten per period in beet feeding experiment to pigs.					
1899-1900.	Lot I. Fed sugar beets.			Lot II. Fed no beets.	
Period.	Corn meal.	Shorts.	Sugar Beets.	Corn meal.	Shorts.
1. Nov. 8-15	14 lbs. 8 ozs.	27 lbs. 12 ozs.	21 lbs. 4 ozs.	20 lbs. 4 ozs.	37 lbs. 0 ozs.
2. Nov. 15-22	21 lbs. 0 ozs.	42 lbs. 0 ozs.	42 lbs. 0 ozs.	24 lbs. 8 ozs.	49 lbs. 0 ozs.
3. Nov. 22-29	21 lbs. 0 ozs.	42 lbs. 0 ozs.	42 lbs. 0 ozs.	24 lbs. 8 ozs.	49 lbs. 0 ozs.
4. Nov. 29-Dec. 6	24 lbs. 8 ozs.	49 lbs. 0 ozs.	61 lbs. 0 ozs.	31 lbs. 8 ozs.	63 lbs. 0 ozs.
5. Dec. 6-13	24 lbs. 8 ozs.	49 lbs. 0 ozs.	70 lbs. 0 ozs.	31 lbs. 8 ozs.	63 lbs. 0 ozs.
6. Dec. 13-20	24 lbs. 8 ozs.	48 lbs. 8 ozs.	98 lbs. 0 ozs.	42 lbs. 0 ozs.	84 lbs. 0 ozs.
7. Dec. 20-27	24 lbs. 8 ozs.	49 lbs. 0 ozs.	112 lbs. 0 ozs.	42 lbs. 0 ozs.	84 lbs. 0 ozs.
8. Dec. 27-Jan. 3	24 lbs. 8 ozs.	49 lbs. 0 ozs.	154 lbs. 0 ozs.	42 lbs. 0 ozs.	84 lbs. 0 ozs.
9. Jan. 3-10	28 lbs. 0 ozs.	56 lbs. 0 ozs.	154 lbs. 0 ozs.	42 lbs. 0 ozs.	84 lbs. 0 ozs.
10. Jan. 10-17	28 lbs. 0 ozs.	56 lbs. 0 ozs.	182 lbs. 0 ozs.	49 lbs. 0 ozs.	98 lbs. 0 ozs.
11. Jan. 17-24	35 lbs. 0 ozs.	70 lbs. 0 ozs.	182 lbs. 0 ozs.	56 lbs. 0 ozs.	112 lbs. 0 ozs.
12. Jan. 24-31	42 lbs. 0 ozs.	84 lbs. 0 ozs.	182 lbs. 0 ozs.	63 lbs. 0 ozs.	126 lbs. 0 ozs.
13. Jan. 31-Feb. 7	42 lbs. 0 ozs.	84 lbs. 0 ozs.	128 lbs. 0 ozs.	49 lbs. 8 ozs.	99 lbs. 0 ozs.
14. Feb. 7-14	42 lbs. 0 ozs.	84 lbs. 0 ozs.	140 lbs. 0 ozs.	49 lbs. 0 ozs.	98 lbs. 0 ozs.
Total—98 days	396 lbs. 0 ozs.	790 lbs. 4 ozs.	1568 lbs. 4 ozs.	566 lbs. 12 ozs.	1130 lbs. 0 ozs.

This table shows that lot I ate 396 pounds of corn meal, 790¼ pounds of shorts and 1568¼ pounds of sugar beets, while lot II ate 566¾ pounds of corn meal and 1130 pounds of shorts, or lot II ate a total of 510½ pounds more of grain than lot I. The pigs seemed to relish the roots and ate them with an appetite never shown by the pigs fed mangels the previous year.

The market values of the foods fed, the amounts eaten and the gains in weight by each lot, are the important factors in the results of the feeding.

The figures relating to values, are based on the cost of the milling products to the Station, and the estimated value of the sugar beets for general feeding.

Lot I.

was fed 396 lbs corn meal at 80 cts. per 100 lbs	$ 3.17
was fed 790¼ lbs. shorts at 75 cts. per 100 lbs	5.93
was fed 1568¼ lbs. beets at 20 cts. per 100 lbs	3.14
Total value food eaten by Lot I	12.24

Lot II.

was fed 566¾ lbs. corn meal at 80 cts. per 100 lbs	$ 4.53
was fed 1130 lbs. shorts at 75 cts. per 100 lbs	8.47
Total value food eaten by Lot II	13.00

This shows that the total food eaten by lot II cost but 76 cents more than that of lot I.

If now we compare the cost of food with cost of gain, we get the following results:

	Lot I	Lot II
Cost of food fed	$12.24	$13.00
Total pounds of gain made	382	443.5
Average daily gain made in pounds	3.89	4.52
Pounds meal and shorts to make pound gain	3.10	3.82
Cost of food for each pound gain	.032	.0293
Cost of food for each 100 lbs. gain	3.20	2.93

These figures show that the cost of the gain in live weight was twenty-seven cents more per hundred for those fed the beets than for those fed the grain only. While this difference is not large, it is important enough to amount to a considerable figure if extensive feeding were conducted with similar results.

The amounts of dry matter consumed by each lot furnish interesting information of the real amounts of food required. The following table brings this out:—

Digestible food in pounds consumed by pigs.

Food fed.	Lot I				Lot II			
	Dry matter	Protein	Carbo-hydrates	Fat	Dry matter	Protein	Carbo-hydrates	Fat
396 lbs. corn meal.....	354.02	30.89	264.13	16.03				
790¼ lbs. shorts.......	697.00	96.41	395.12	30.03				
1568¼ lbs. sugar beets.	204.71	17.25	159.96	1.57				
566¾ lbs. corn meal...					506.67	44.21	378.02	24.37
1130 lbs. shorts.......					996.66	137.86	565.00	42.94
Total..............	1255.73	144.55	819.21	47.63	1503.33	182.07	943.02	67.31

This table shows that lot II, which gained 61½ pounds the most, ate 247.60 pounds more dry matter, 37.52 pounds more protein, 123.81 pounds carbohydrates and 19.68 pounds more fat than did lot I.

While the results from feeding beets to fattening pigs showed no material benefit, it is believed that the beets gave a beneficial influence on the digestive tract, and had brood sows been fed, the beets would have been to their material advantage.

Experiments by Others on Mangels, Beets and Carrots.

In his work on "Feeds and Feeding," Henry quotes at considerable length certain Danish feeding experiments on pigs. In reference to the use of roots, I wish to quote from some of the statements made. In comparing mangels and grain, all the lots received skim milk or whey in addition to grain and roots, excepting lots E and F, to which an equivalent of additional roots was given. It is shown that ten pounds of mangels more than equal and eight pounds about equal one pound of grain in trials. The quality of the pork produced by the different lots was very satisfactory. Even where one-fourth the daily feed was given in the form of mangels no ill effect was noted.

In 1890 a preliminary feeding experiment was made, using beets with different sugar contents, to ascertain their comparative feeding values. Mangels containing 12.71 per cent. dry matter and 8.93 per cent. sugar were fed against fodder beets containing 19.86 per cent. of dry matter and 13.8 per cent. of sugar, or against barley. The experiment included twenty-five pigs, averaging 79 pounds each and lasted seventy days. The indications were, for pigs, one pound of barley had a feeding value equal to six or eight pounds mangels or four to eight pounds of fodder beets. In 1891-92, 204 pigs were fed four kinds of roots, in addition to daily refuse and grain. There were fed:—

	Dry matter	Sugar
(1) Eckendorf mangels containing.....	11.0 per cent.	6.0 per cent.
(2) Elvetham mangels containing......	13.0 per cent.	8.9 per cent.
(3) Fodder sugar beets containing.....	16.5 per cent.	10.9 per cent.
(4) Sugar beets containing............	21.2 per cent.	14.0 per cent.

Lots fed barley only, made the largest gain, closely followed by those half of the grain of which was replaced by roots in the

following ration: For one pound barley substituted 7.5 pounds Eckendorf mangels, 6.5 pounds Elvetham mangels, five pounds fodder beets and four pounds sugar beets. These quantities of different kinds of roots proved nearly equivalent in feeding value. The conclusion was arrived at that about 40 per cent. of the daily ration of the pig may be advantageously made up of roots. Slaughter showed pork from pigs fed roots fully equal to those fed grain only. Carrots are not a profitable crop to grow for feeding live stock, owing to the expenses of cultivating and harvesting. Long states (2) that they have long been used for pigs, although they are too rich for feeding animals.

In the Danish feeding experiments above referred to in 1891-94 on nine different estates, 893 pigs were divided into 175 lots. In comparative trials carrots and mangels containing equal quantities of dry matter had similar value in pig feeding. It was shown that the amount of dry matter in roots is of importance, rather than the total weight or quantity of sugar contained.

Later nine experiments with 277 animals in 54 lots were conducted for the study of relative values of barley, mangels and carrots. Two kinds of mangels and four kinds of carrots were used. Dairy refuse was fed all the lots. Roots were fed in such quantities that 0.84 pounds of dry matter in roots corresponded to one pound of grain. The experiments lasted 80 to 130 days, the average being 102 days. The pigs averaged 66 pounds at the beginning of the experiment and 169.6 pounds at the end. The average daily gain made by the lots on different rations was as follows:

Barley	0.986 lb.
Eckendorf mangel wurzels	0.828 lb.
Elvetham mangel wurzels	0.833 lb.
Vogeser and Champion carrots	0.875 lb.
James and Giant	0.900 lb.

The gains made on roots in these experiments are not up to the previous ones. Carrots are shown to be of similar feeding value for pigs as mangels when equal amounts of dry matter are fed.

Rape for Swine.

Rape at the present time is the most favorably known of the fleshy-leaved plants for swine pasture, and while but a comparatively

(2) Book of the Pig, 1886, p. 254.

small number of trials have been reported showing the value of rape for this purpose, these have attracted sufficient attention to justify further trial.

At the Indiana Station for three weeks during the summer of 1898 we fed rape to pigs. Eighteen Chester White pigs were selected, weighing from 60 to 120 pounds on July 5. These were divided into two lots of nine each, five sows and four barrows being in each group. Each lot was kept confined in a small lot free of vegetation. Lot I was fed such fresh cut rape as it would eat, in addition to a mixture of half corn meal and half shorts, with some skim milk to drink daily. Lot II received the same kind of feed, less the rape. During the three weeks Lot I gained 164½ pounds in weight, or an average of .86 pounds per day per pig, while lot II, which received no rape, gained 233.5 pounds in 21 days, or an average of 1.18 pounds per day per pig. During this trial lot I ate 274½ pounds of corn meal, 274½ pounds of shorts, 208¾ pounds skim milk and 395 pounds of rape, while lot II ate 366½ pounds each corn meal and shorts and 276 pounds of skim milk. If now we figure the corn meal at 80 cents per 100, shorts at 60 cents, skim milk at 15 cents and rape at five cents per 100 pounds each, we find that each pound of flesh in lot I cost 2.65 cents and in lot II 2.47 cents. While these figures show that the cost of production in each case was an economical one, the balance is in favor of the pigs that received no rape.

At the Wisconsin Station two trials of feeding rape to swine have been reported (3) including in all 58 hogs. In both these experiments one lot of pigs was penned and fed soaked corn and also shorts in a slop, consisting of two parts corn and one part shorts by weight. The other lot had the same grain feed with a limited amount of rape in addition. In the first trial the 10 hogs on rape ate in 76 days 1,386 pounds of corn, 690 pounds of shorts and .32 acre of rape, and gained 853 pounds. The other lot penned ate 2,096 pounds of corn, 1,042 pounds shorts and gained 857 pounds. As the gain is essentially the same in each lot the third of an acre of rape saved 1,062 pounds of grain or an acre of rape would be worth 3,318 pounds of grain. In another trial of two lots of 19 each, conducted in the same manner and fed the same rations for 49 days, the rape lot ate 2,220.3 pounds of corn, 1,109 pounds of shorts, .6

(3) Bulletin 58, Wisconsin Exp. Station, April, 1897.

acre of rape and gained 1,066 pounds. The penned lot ate 3,106.5 pounds of corn, 1,553 pounds of shorts and gained 1,076 pounds. The gain is practically the same in this instance also, so that it may be said that the .6 acre of rape saved 886.2 pounds of corn and 444 pounds of shorts, or that one acre of rape is worth 2,217 pounds of grain. The average of the two trials indicates that an acre of rape is worth 2,767 pounds of such grain for fattening hogs.

Artichokes for Swine.

Artichokes for many years have been known as suitable food for pigs, and the live stock and agricultural press have published much relative to the value of this plant for swine. The writer's experience with artichokes has not been so encouraging as reported by others, but perhaps this is due to a somewhat limited experience. Four sows placed in a small field of artichokes that had not been disturbed made a total gain in weight between Oct. 25 and Nov. 8 of 27 pounds. They rooted out the artichokes and were fed in addition 57½ pounds each of corn meal and shorts. Each pig gained much the same in weight. These pigs would, no doubt, have done better had there been a larger area of artichokes to feed on, so that the experiment might have been longer continued. As it was they practically cleaned the lot of all tubers.

Some very flattering reports have been made on artichokes. Coburn quotes A. C. Williams, (4) a prominent and successful Poland China breeder in Iowa, years ago, as writing:—

"The keep of my hogs in warm weather is blue grass, clover and Brazilian artichokes. Forty head of hogs and their pigs may be kept without other food on an acre of artichokes from the time frost is out of the ground until the first of June, and from September or October until the ground is again frozen."

At the Oregon Experiment Station six Berkshire pigs weighing from 113 to 215 pounds each were fed artichokes and grain from Oct. 22 to Dec. 11. They gained 244 pounds in weight, or an average daily gain of 0.81 pounds. The pigs ate 756 pounds of grain during this period which is 3.1 pounds of grain for each pound of gain in live weight. In other experiments it was found that it required five pounds of mixed grain to produce a pound of gain, hence

(4) Swine Husbandry, 1877, page 112.

on this basis the artichokes consumed would represent two pounds of grain in producing each pound of gain in live weight. The pigs consumed the artichokes on one-eighth of an acre, rooting them all out. (5).

Sweitzer of the Missouri Station reports a trial by Porter in which artichokes and wheat meal were fed pigs. It required 325 pounds of wheat meal and 820 pounds of artichokes to produce 100 pounds of increase. (6) In none of the reports on feeding artichokes are results secured in gain of live weight that have not repeatedly been attained by feeding no larger amount of grain than is indicated in these trials where no artichokes were used.

Purslane or Pusley for Swine.

Purslane or pusley, a very succulent common weed, has not been generally used for feed, but it possesses some merits. In 1898 at the Indiana Station, for 21 days purslane was fed two Chester White sows. The pigs were of about the same size and age and the purslane was well developed when fed. From Sept. 21 to Oct. 11 the sows were confined in a small yard or pen. They were fed a mixture of half shorts and half hominy meal, twice a day as a slop, and all the purslane they would eat. During this time the pigs consumed 61½ pounds each of hominy feed and shorts and 390 pounds of purslane. One pig weighed 162 pounds on Sept. 20 and 182½ pounds on Oct. 11, a gain of 20½ pounds, and the other weighed 157 pounds on Sept. 20, and 174 pounds on Oct. 11, a gain of 17 pounds. Rating hominy feed at 65 cents per one hundred weight and shorts at 70 cents per one hundred weight, this gain in weight would cost 2.2 cents per pound. The pigs consumed about 18½ pounds of purslane per day between them. It was eaten with the relish that was to lane per day between them. It was not eaten with the relish that was to be expected, yet the pigs did very well while receiving it, making fair daily gains.

Pumpkins for Swine.

Pumpkins have for years been fed by our farmers to some extent to pigs, and while they have as a rule, met with favor, we know little of their feeding value on the basis of reports. The Oregon Station fed pumpkins to six Berkshire pigs, which were about eight

(5) Bulletin 54, Oregon Agr. Ex. Station, 1898.
(6) Bulletin 29, Missouri Ex. Station.

months old, when the experiment began. The pumpkins were cooked in a vat and mixed with shorts. They were fed from October 30 to December 25. Reckoning pumpkins at $2.50 per ton and shorts at $12.00, the amount of the former fed was worth $9.40 and the latter $5.54, a total of $14.94. The total gain in live weight was 499 pounds, making the cost of the food for 100 pounds of gain in live weight $2.00. The pigs consumed large amounts of pumpkins, averaging for the two last feeding periods 26 pounds each per day. At first only small amounts of shorts were necessary, but later this amount had to be increased. The average daily gain for the entire period was one and one-half pounds per pig. The quality of the meat was very fine. (7).

The real value of succulent food for swine cannot be measured by simple gains in weights of pigs given such food. Undoubtedly where animals are confined to a pure grain diet, the digestive tract is more torpid and sickness is more likely to occur than when succulent food is given. Then the digestive organs are more active and natural in movement and the body is better prepared to resist disease than when pure grain food is fed. The influence of this succulent food on sows in pig or sucking pigs cannot be measured by the scales, but the general testimony of practical feeders of experience is that such diet promotes easy parturition, a generous milk flow and vigorous offspring. Pigs that are to be fattened in a short period of feeding do not perhaps need roots in their diet, though I believe it would be to their advantage, but breeding stock, both male and female, and suckling sows will certainly be materially benefited by summer pasturage and roots in winter. Swine should always be fed with discretion the first few days after turning on pasture to prevent bloat, but where roots are fed no special danger is likely to occur.

Of the summer pasture plants, red clover and rape are undoubtedly the most desirable, while the sugar beet and mangel wurzel, all things considered, offer the cheapest food in the form of roots. Possibly swedes or kohlrabi are equally desirable, though they are probably more of an unknown quantity with American feeders than the other two. Those roots with the greatest amount of sugar in them, however, will be eaten with more relish, and probably give the best returns, as is shown in the Danish experiments where the sugar contents of beets is reported.

(7) Bulletin 54, Oregon Agr. Ex. Station,, 1898.

Indiana Agricultural Experiment Station

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" 76. Skim milk as a food for young growing chickens. March.
" 77. Field experiments with corn. Mangel wurzels and the cost of production. Formalin for grain and potatoes. March.
" 78. San Josè and other scale insects and the Indiana nursery inspection law. May.
" 79. Roots as food for pigs. June.
" 80. Sheep scab. September.
" 81. Field Tests with fertilizers on heavy clay lands. Dec.
" 82. Roots and other succulent food for swine. March, 1900.

PURDUE UNIVERSITY.

Indiana Agricultural Experiment Station.

C. S. PLUMB, Director.

LaFayette, Indiana. Bulletin No. 86, December, 1900.

On the amount of water in slop fed fattening pigs.

BY C. S. PLUMB AND H. E. VAN NORMAN.

From time to time the question has been asked by visitors to the Indiana experiment station, "How thin or how thick should the slop for pigs be made?" This same subject has been discussed to some extent in feeders' meetings, as well as in conversation among pig feeders. So far as the writers are aware, however, there is no information on this subject in printed form, whereby one may cite the results of investigation. Many persons think that ground feed should be moistened just enough to pour it well from the pail to trough, yet not be very watery, while others desire the slop to be quite liquid. No one, however, seems to have thus far published any facts of importance in this interesting field.

With a view of studying this subject, the following experiment was begun at this station on January 24, 1900, and continued till June 19, a period of 146 days.

The animals used were sixteen in number, consisting of eight pure bred Chester Whites and eight Berkshires. These were divided into four lots of four each, with two of each breed in each lot. One Chester White in each lot was farrowed on September 14, and one on September 21, while all the Berkshires were farrowed October 17. Lots I and IV each contained a barrow, while lots II and III each contained two barrows, there being one of each breed. The males are numbers 278, 286, 298, 289, 292 and 285.

The foods used were a mixture of equal parts of pure corn meal and shorts till the period beginning May 9 after which

Pounds Foods Fed Per Period to Pigs Lots A. B. C. D.

Date.	Lot A. Dry Feed.		Lot B. 1 part grain 1 water		Lot C. 1 p't grain 2 water.		Lot D. 1 p't grain 3 water	
1900	Corn Meal.	Shorts.	Corn Meal.	Shorts.	Corn Meal.	Shorts.	Corn Meal.	Shorts.
Jan. 24-31......	29.	29.	33.75	33.75	29.75	29.75	27.	27.
Jan. 31-Feb. 7.	19.	19.	34.5	34.5	31.5	31.5	29.5	29.5
Feb. 7-14......	31.	31.	39.	39.	39.	39.	36.25	36.25
Feb. 14-21......	35.	35.	42.5	42.5	42.5	42.5	38.5	38.5
Feb. 21-28......	42.	42.	42.	42.	42.	42.	42.	42.
Feb. 28-Mch. 7.	40.5	40.5	42.	42.	42.	42.	42.	42.
Mch. 7-14.....	42.	42.	42.	42.	42.	42.	42.	42.
Mch. 14-21.....	42.	42.	42.	42.	42.	42.	42.	42.
Mch. 21-28.....	48.	48.	48.	48.	48.	48.	48.	48.
Mch. 28-Apr. 4.	49.	49.	49.	49.	49.	49.	49.	49.
Apr. 4-11......	49.	49.	49.	49.	49.	49.	49.	49.
Apr. 11-18......	49.	49.	49.	49.	49.	49.	49.	49.
Apr. 18-25......	56.	56.	56.	56.	56.	56.	56.	56.
Apr. 25-May 2.	63.	63.	63.	63.	63.	63.	63.	63.
May 2- 9.......	63.5	63.5	68.5	68.5	68.5	68.5	67.	67.
	Hominy		Hominy		Hominy		Hominy	
May 9-16.......	70.	70.	70.	70.	70.	70.	70.	70.
May 16-23......	77.	77.	77.	77.	77.	77.	77.	77.
May 23-30......	84.	84.	84.	84.	84.	84.	72.	72.
May 30-June 6.	84.	84.	98.	98.	98.	98.	84.	84.
June 6-13......	84.	84.	98.	98.	98.	98.	84.	84.
June 13-20......	84.	84.	98.	98.	98.	98.	84.	84.
Total	1141.	1141.	1225.25	1225.25	1218.25	1218.25	1151.25	1151.25

hominy feed took the place of the corn meal, and they were fed under these conditions:

Lot I was fed the food dry in the trough.

Lot II was fed the grain mixed with its weight of water.

Lot III was fed the grain mixed with twice its weight of water.

Lot IV was fed the grain mixed with three times its weight of water.

Each lot of pigs was given all the water desired additional to that mixed with the grain, and a record was kept of the amount of water drunk daily. The pigs also had access to ashes and salt.

The pigs were fed about 7.00 a. m. and 5.30 p. m., and were weighed once a week, about 11.00 in the morning. Mr. Van Norman supervised all feeding and weighing. As a matter of convenience the feeding periods are in seven day groups.

The pigs were fed in pens 7x8 feet in size, and occupied separate quarters for sleeping rooms. The animals were generally in first class health during the experiment.

The number of each pig, sex, breed and weight in each lot on January 24 is herewith given.

Lot I.

No. 278.	Male.	Chester White, weight......	86.5 lbs.
No. 287.	Female.	Chester White, weight....	56.0 lbs.
No. 295.	Female.	Berkshire, weight.........	43.0 lbs.
No. 297.	Female.	Berkshire, weight.........	55.0 lbs.
		Total..................................	240 5 lbs.

Lot II.

No. 283.	Female.	Chester White, weight....	71.5 lbs.
No. 286.	Male.	Chester White, weight......	63.0 lbs.
No. 290.	Female.	Berkshire, weight.........	61.0 lbs.
No. 298.	Male.	Berkshire, weight...........	42.0 lbs.
		Total..................................	237.5 lbs.

Lot III.

No. 282.	Female.	Chester White, weight....	75.0 lbs.
No. 289.	Male.	Chester White, weight......	57.5 lbs.
No. 292.	Male.	Berkshire, weight...........	54.5 lbs.
No. 296.	Female.	Berkshire, weight.........	51.5 lbs.
		Total..................................	238.5 lbs.

Lot IV.

No. 280.	Female.	Chester White, weight....	76.0 lbs.
No. 285.	Male.	Chester White, weight......	52.0 lbs.
No. 291.	Female.	Berkshire, weight.........	40.0 lbs.
No. 294.	Female.	Berkshire, weight.........	70.0 lbs.
	Total	....	238.0 lbs.

An examination of these figures shows no important difference in the results secured. They show, however, that

Lot A gained 634. pounds in 146 days or 4 1-3 lbs. per day.
Lot B gained 644 1 2 pounds in 146 days or 4 2-5 lbs. per day.
Lot C gained 650 1-2 pounds in 146 days or 4 2-5 lbs. per day.
Lot D gained 614 pounds in 146 days or 4 1-5 lbs. per day.

These figures also show that each of the four pigs gained slightly over a pound in weight per day during the experiment.

As is to be expected, the poorest gains were made in severely cold weather, and the best in the latter part of the experiment, when the temperature was mild and comfortable. In May some of the pigs averaged a gain of over two pounds daily, and grew very rapidly.

The amount of food consumed in relation to gain in weight is an important matter, as is also the amount of water drunk. The table on page 152 shows how much grain was fed each lot.

From this it will be seen that

Lot A ate 2,282 lbs. corn meal and shorts or hominy, half and half.
" B " 2,450½ " " " " " " " " " "
" C " 2,436½ " " " " " " " " " "
" D " 2,302½ " " " " " " " " " "

If these figures be compared with the gains in live weight, it will be seen that

To make one pound of gain Lot A ate 3.59 lbs. of grain.
To make one pound of gain Lot B ate 3.80 lbs. of grain.
To make one pound of gain Lot C ate 3.74 lbs. of grain.
To make one pound of gain Lot D ate 3.75 lbs. of grain.

The tables on pages 156 and 157 give the weekly weights of each pig, the average weight of the pigs in each lot and the total weight per lot.

Total pounds of water given per lot per period, and average amount per pig per day.

Period.	LOT A.		LOT B.		LOT C.		LOT D.	
	Total per period.	Daily average per head.	Total per period.	Daily average per head.	Total per period.	Daily average per head.	Total per period.	Daily average per head.
Jan. 24-31........	66.	2.35	68.	2.42	119.25	4.25	162.37	5.79
Jan. 31-Feb. 7...	67.	2.39	68.	2.42	126.	4.50	177.	6.32
Feb. 7-Feb. 14...	70.	2.50	77.	2.75	155.	5.53	217.5	7.76
Feb. 14-Feb. 21...	70.	2.50	92.	3.27	169.	6.03	231.	8.25
Feb. 21--Feb. 28..	84.	3.00	100.	3.57	168.	6.00	252.	9.00
Feb. 28-Mch. 7...	84.	3.00	94.	3.35	168.	6.00	252.	9.00
Mch. 7-Mch. 14..	68.	2.42	84.	3.00	168.	6.00	252.	9.00
Mch. 14-Mch. 21..	84.	3.00	92.	3.27	168.	6.00	252.	9.00
Mch. 21-Mch. 28..	118.	4.21	102.	3.64	192.	6.85	288.	10.28
Mch. 28-Apr. 4...	106.	3.78	126.	4.50	196.	7.00	294.	10.50
Apr. 4-Apr. 11...	135.	4.82	146.	5.21	196.	7.00	294.	10.50
Apr. 11-Apr. 18...	140.	5.00	132.	4.71	196.	7.00	294.	10.50
Apr. 18-Apr. 25...	155.	5.53	157.	5.60	224.	8.00	336.	12.00
Apr. 25-May 2...	210.	7.50	196.	7.00	252.	9.00	378.	13.50
May 2-May 9...	195.	6.96	172.	6.14	274.	9.78	422.	15.07
May 9-May 16...	253.	9.03	184.	6.57	280.	10.00	420.	15.00
May 16-May 23...	320.	11.42	210.	7.50	308.	11.00	462.	16.50
May 23-May 30...	295.	10.53	229.	8.17	336.	12.00	432.	15.42
May 30-June 6...	264.5	9.44	235.	8.39	392.	14.00	504.	18.00
June 6-June 13..	280.	10.00	238.	8.50	392.	14.00	504.	18.00
June 13-June 20..	310.	11.07	229.	8.17	392.	14.00	504.	18.00
Total	3374.5		3031.		4871.25		6927.87	

Weights of Pigs in Pounds.

Lot A. Grain fed dry.							Lot B. One part grain, one part water.					
No. 278	No. 287	No. 297	No. 295	Total.	Average weig't	Date 1900	No. 283	No. 286	No. 290	No. 298	To l.	Average weight
86.5	56.	55.	43.	240.5	60.1	Jan. 24	71.5	63.	61.	42.	237.5	59.3
89.	58.	55.	44.	246.0	61.5	Jan. 31	78.5	63.	61.	41.5	244.0	61.0
85.5	60.5	57.5	45.	248.5	62.1	Feb. 7	83.	69.	64.5	46.	262.5	65.6
88.	67.	62.	48.	265.0	66.2	Feb. 14	91.	75.	73.	46.5	285.5	71.3
91.	74.	66.	50.	281.0	70.2	Feb. 21	95.	79.	78.	49.	301.0	75.2
98.	81.	73.	56.	308.0	77.	Feb. 28	101.5	85.	85.5	54.	326.0	81.5
101.5	87.5	81.	59.	329.0	82.2	Mch. 7	107.5	90.5	90.5	58.	346.5	86.6
105.	93.	85.	62.	345.0	86.2	Mch. 14	111.	95.	98.5	60.	364.5	91.1
108.	100.	90.	65.	363.0	90.7	Mch. 21	117.	100.	106.	65.	388.0	97.0
115.	112.5	101.	70.	398.5	99.6	Mch. 28	128.	109.	114.	69.	420.0	105.0
120.5	118.	105.	75.	418.5	104.6	April 4	136.	113.	123.	75.	447.0	111.7
126.	128.	112.	79.	445.0	111.2	April 11	142.	121.	131.	81.	475.0	118.7
130.	135.	120.	84.5	469.5	117.3	April 18	150.	125.	138.	85.	498.0	124.5
139.	143.	129.	90.	501.0	125.2	April 25	157.	131.5	147.	90.	525.5	131.3
149.	154.	140.	98.	541.0	135.2	May 2	161.	140.	160.	96.	557.0	139.2
159.	163.	150.	102.5	574.5	143.6	May 9	169.	150.	171.	105.	595.0	148.7
171.	175.	164.	115.	625.0	156.2	May 16	179.	161.	183.	113.	636.0	159.0
184.	192.	179.	124.5	679.5	169.8	May 23	189.5	171.	199.	127.	686.5	171.6
193.	208.	196.	135.5	732.5	183.1	May 30	202.	183.	210.	140.	735.0	183.7
205.	218.	213.	146.	782.0	195.5	June 6	218.	202.	229.	155.	804.0	201.0
222.	229.	221.	158.	830.0	207.5	June 13	227.	221.	240.	171.	859.0	214.7
230.	242.	234.	168.	874.0	218.5	June 20	233.	223.	247.	179.	882.0	220.5
143.5	186.	179.0	125.0	633.5	158.5	T. gain	161.5	160.0	186.0	137.0	644.5	161.2

Weights of Pigs in Pounds.

Lot C. One part grain, two parts water.							Lot D. One part grain, three parts water.					
No. 282	No. 289	No. 292	No. 296	Total weekly wt.	Ave. weekly wt	Date 1900	No. 280	No. 285	No. 291	No. 294	Total weekly wt.	Average weekly weight.
75.	57.5	54.5	51.5	238.5	59.6	Jan. 24	76.	52.	40.	70.	238.0	59.5
82.	60.	55.	50.5	247.5	61.8	Jan. 31	77.	56.	38.5	72.5	244.0	61.0
82.	67.	58.	56.	263.0	65.7	Feb. 7	80.	58.	41.	75.	254.0	63.5
88.	74.	62.	62.	286.0	71.5	Feb. 14	90.	61.	45.	83.	289.0	72.2
90.	78.	67.	65.	300.0	75.0	Feb. 21	93.	66.	46.	88.	293.0	73.2
95.	85.	73.5	71.5	325.0	81.2	Feb. 28	102.	71.	52.	97.	322.0	80.5
97.	90.	77.	73.	337.0	84.2	Mch. 7	106.	76.	54.5	100.	336.5	84.1
100.5	96.5	84.	78.	359.0	89.7	Mch. 14	112.	84.	56.5	107.5	360.0	90.0
102.5	102.5	89.5	83.5	378.0	94.5	Mch. 21	115.	84.	60.	113.	372.0	93.0
110.	114.	100.	92.	416.0	104.0	Mch. 28	122.	93.	65.	125.	405.0	101.2
114.	121.	106.	98.	439.0	109.7	April 4	132.	99.	71.	132.	434.0	108.5
117.5	129.	112.	104.	462.5	115.6	April 11	137.5	105.	74.5	139.	456.0	114.0
121.	131.	117.	109.	478.0	119.5	April 18	142.	110.	79.	145.	476.0	119.0
126.	140.	124.	116.	506.0	126.5	April 25	153.	119.	83.	156.5	511.5	127.8
133.	151.	134.	127.5	545.5	136.3	May 2	158.	127.5	93.	168.	546.5	136.6
141.	160.	144.	135.	580.0	145.0	May 9	170.	133.	98.	180.	581.0	145.2
149.	172.	157.	146.	624.0	156.0	May 16	182.5	144.	110.	189.	625.0	156.2
155.	187.	171.5	163.	676.5	169.1	May 23	189.	157.	122.	206.	674.0	168.5
164.	200.	185.	177.	726.0	181.5	May 30	192.	161.	131.	214.	698.0	174.5
176.	215.	204.	190.	785.0	196.2	June 6	206.	177.	145.	234.	762.0	190.5
186.5	234.	218.	206.	844.5	211.1	June 13	218.	185.	158.	254.	815.0	203.7
195.	249.	229.	216.	889.0	222.2	June 20	225.	195.	170.	262.	852.0	213.0
120.0	191.5	174.5	164.5	650.5	162.6	T. gain	149.0	143.0	130.0	192.0	614.0	153.5

As the cost of the food fed averaged about 80 cents per hundred pounds

The cost per pound of gain was 2.87 cents in Lot A.
The cost per pound of gain was 3.04 cents in Lot B.
The cost per pound of gain was 2.99 cents in Lot C.
The cost per pound of gain was 3.00 cents in Lot D.

The amount of water given the different lots is especially worthy of notice. No water was given with the grain in lot A, but such water as might be desired was weighed out and turned in the trough after the grain was eaten up clean. Neither did lot B receive sufficient water with its grain to meet natural demands, so that extra water was weighed to the pigs in this lot, while lots C and D required no more water than that in the grain. The table on page 155 is of special interest, as showing something of the amount of water consumed by a pig per day. Perhaps some of the pigs may have drunk some rain water standing in the lots during the course of the experiment, but of that it is impossible to have any record.

The table shows that lot A was fed more water than lot B by 343½ lbs., and that lot C was given 4871¼ lbs. and lot D 6927⅞ lbs. The figures also bring out the fact that pigs weighing 60 pounds, fed dry feed, consumed on an average 2.35 lbs. water daily, and that this amount increased nearly constantly until these same pigs weighing 218 lbs. consumed 11.07 lbs. per day. It is also shown that pigs fed water in their food as a slop, when weighing about 60 lbs., consumed either 2.42, 4.25 or 5.79 lbs. of water per day, while these same pigs weighing 213 to 222 lbs. consumed either 8.17, 14 or 18 lbs. of water per day. Undoubtedly much of this water was consumed unnecessarily, and certainly lot D was given much more water with its grain than was required.

There was no material difference in the appearance of the pigs in either lot, so far as quality is concerned, and so far as this one experiment goes, the use of about two times the weight of water to grain indicates a satisfactory proportion. In view of the fact that the pigs fed dry grain made slightly the best gains, it would appear that there is really no gain in feeding the pigs a slop instead of a dry grain, excepting as a feeder may regard it a matter of convenience.

MISSOURI
Agricultural College Experiment Station.

BULLETIN No. 29.

APRIL, 1895.

Feeding Wheat to Pigs.

INTRODUCTORY.

The experiment reported in this Bulletin was designed under the directorship of Dr. E. D. Porter and carried out in every detail by Mr. C. M. Conner. The illness and subsequent death of the director placed the responsibility of arranging and publishing the results upon the writer, who has drawn from them such conclusions as seemed to him both proper and logical. For these he alone must be held responsible, while to Mr. Conner belongs the credit of taking and recording the daily and periodical weights and making such notes during the progress of the trial as seemed desirable.

P. SCHWEITZER,
ACTING DIRECTOR.

FEEDING WHEAT TO PIGS.

P. SCHWEITZER.

The low price of wheat during the past few years has induced a number of experiment stations to conduct feeding trials with farm animals, whose chief object has been to determine whether feeding wheat was sufficiently remunerative to the farmer to induce him to continue raising it. To put the question in this form means, of course, that the raising of wheat at 50 cents a bushel and fifteen bushels per acre does *not* pay, and that it can only remain a staple crop in case we are able to increase its yield to twenty-five or thirty bushels without additional cost of production, or are unable to replace it in a true system of rotation by another crop that would maintain as well the equilibrium between the agricultural input and outgo of the land. The writer sees relief for the future of agriculture in both of these directions and confidently believes in its ultimate re-establishment as the safeguard and foundation stone of state and society.

The inquiry was sought to be answered by experiments with cattle, dairy stock and pigs, and, though the results demonstrated, *in a general way,* the value of wheat for feeding purposes, they did not settle the question as to whether wheat, when thus fed, is yet a profitable crop, nor whether selling it at present prices and investing the pro-

ceeds in other, different, feeds might not, after all, be still better. In fact, the question, like all questions in which politico-economical considerations are permitted to enter, does not admit of strictly scientific formulation and brings, therefore, no clear and definite answer.

The experiments at this station were made with pigs and are quite comprehensive; they embraced a feeding period of ninety days, with a preparatory period of nine days, in which the treatment of each lot was precisely as it was to be during the trial. Each lot, excepting No. 10 to No. 13, consisting of three animals of different ages and weights, which were selected in such manner as to make the lots themselves as near equal in these respects as it was possible to have them. All animals were high grade Berkshires and, at the beginning of the trial, healthy, and well developed. They continued in the main, to remain so, though an occasional falling off in feed and weight occurred to mar the even progress of the experiment, which, perhaps, is not to be regretted since it may in itself offer a lesson to profit by. Each lot was confined in a pen, ten by eighteen feet square, made of close fitting fence boards four feet in height, and having the northern end roofed over, but open to the south for sun and air; they had straw for a bedding, which was renewed frequently to insure cleanliness and comfort. An extra trough was put in each pen with a mixture of hardwood ashes, stone coal and salt. Of the feed, as much was given as the animals would eat up clean while, at the same time, a close watch was kept to prevent waste; of the mixed rations enough was prepared to last for ten days; this was put in bins and any surplus at the end of ten days weighed back and deducted. Where the feed was to be given wet, enough was weighed out to last for three days;

it was then put into tubs holding an equal weight of water and soaked for thirty-six hours, when it was drained and fed; any surplus left over was, as in the previous case, weighed back and deducted. No trouble was experienced in thus keeping account of the feed consumed; but to prevent any mistake at all separate daily records of the food of each lot were kept as a tally, so that all weights recorded here may be assumed to be strictly correct.

The pigs were weighed every tenth day in the same order and manner, and, when this was a Sunday, weighed twice, once on Saturday and then on Monday, and the mean of the two weighings recorded as the true weight for Sunday. All feed was purchased at the local mills at the following prices:

Wheat, $0.55 a bushel.

Wheat chop, $1.00 per 100 pounds.

Corn chop, $1.00 per 100 pounds.

Wheat bran, $0.75 per 100 pounds.

The wheat was good No. 2 wheat, such as was made into flour, and the corn, sound white corn, raised in the county. For the potatoes and artichokes, grown at the station, a valuation of 40 cents a bushel for the former and 30 cents for the latter was assumed to permit of a comparison of the cost of the different rations. All the valuations, especially those of wheat chop, corn chop and bran, are high, and, in fact, higher than should make the basis for the cost of product. Since they were, however, the actual prices which the station paid, they are permitted to stand. No uniform valuation prevails in the different sections of our state, and any farmer can readily fit our results to his own special conditions.

THE RATIONS.

The experiment was primarily undertaken to test the value of wheat as a food for growing and fattening pigs; it was made comprehensive enough to give a relative as well as absolute answer by extending it to pigs of different ages, and varying the rations as seemed practically desirable. The ages of the animals ranged from one month up to two and one-half, four and one-half, five, and six and one-half months at the time of trial, and the rations, thirteen in number, included a thirty days' test of potatoes and artichokes fed, the former boiled and the latter raw, in such amounts as the pigs would eat. Unfortunately the artichokes lasted but forty days, so that the experiment, counting the first ten days a period of preparation, had a length of only one month, which probably prevents drawing from it any general conclusions. The lot fed potatoes was carried through to the end on the same feed, while the other, on the artichokes giving out, was put for the remainder of the time on boiled wheat.

It only remains to say that the experiment began on November 7 and ended on February 14, 1895, that of lots X, XI, XII and XIII being continued a little longer, until sickness and finally death broke it up. All results are tabulated and put in a single table at the end of the bulletin for general comparison, while values bearing upon special points are grouped and discussed separately. The composition of the rations for the different lots was as follows, the parts being in every instance parts by weight:

Lot I.—Four parts of corn chop, one part of bran.

Lot II.—Two parts of corn chop, two parts of wheat chop, one part of bran.

Lot III.—Four parts of wheat chop, one part of bran.

Lot IV.—Wheat chop.

Lot V.—Wheat chop, wet (soaked for thirty-six hours.)

Lot VI.—Four parts of whole wheat, one part of bran, dry.

Lot VII.—Four parts of whole wheat, one part of bran, wet (soaked for thirty-six hours.)

Lot VIII.—Wheat chop and potatoes (boiled.)

Lot IX.—Wheat chop and artichokes (raw.)

Lot X.—Whole wheat, dry.

Lot XI.—Wheat chop, wet (soaked for thirty-six hours.)

Lot XII. Wheat chop and skim-milk (ad libit.)

Lot XIII. Corn meal and skim-milk (ad libit.)

THE RATE OF INCREASE.

The results can be easier apprehended by being tabulated under different headings. The rate of increase per 100 pounds of live weight, as given in the general table, has, therefore, been still further dissected, so as to bring all the animals, according to their respective ages, into five groups. By doing so the fact comes out with striking plainness *that as pigs grow older their rate of increase diminishes.* This, to be sure, is a well known truth, and would not be re-stated here, did not the figures at the same time point to another perhaps equally important truth, which is not so well known, viz: that *animals which are put, when rather young, on a system of full feeding, do not maintain their rate, and fall largely behind others put to it in a more mature condition.*

The lessons from this are plain: 1. *The fattening process, to be profitable, must be short; perhaps not longer than two months, if that;* and 2. *Keep the young animals out of the yard or enclosure where you feed for market.* This second

TABLE II.—Increase per 100 pounds of live weight of pigs of different ages and weights for periods of ten days: This table embraces all the animals under experiment, 29 in all.

Age in days: Nov. 16.	192	152	134	78	33
	12.5	2 25.4	2 29.0	2 6.8 †	2 43.8
	13.1	2 28.0	18 8	2 29.0	2 40.0
	15.0	2 37.2	2 40.2		
	15.1	18 5	16.8		
	9.2	12.6	10.8		
		14.3			
Average.....	13.0	15.1	16 5	8.9 †	20.9
Age in days: Nov. 26.	202	162	144	88	43
	13.2	2 29.4	2 39.6	2 26.4	2 124.
	12.5	2 33 4	16 7	2 21.8	2 129.2
	11.9	2 28.4	2 27.2		
	12.8	13.2	17.6		
	11.3	14.2	17.3		
		16.1			
Average.....	12.3	15.0	16.9	12.1	63.3
Age in days: Dec. 6.	212	172	154	98	53
	6 9	2 14 8	2 9.0 †	2 8.2 †	2 60.2
	5.4	2 17.4	13.9	2 17.6	2 58.2
	9.2	2 9.0	2 29.8		
	6 5	6.9	7.5		
	6.2	5.2	7.6		
		7.3			
Average	6.8	6.7	9.7 †	6.5 †	31.9
Age in days: Dec 16.	222	182	164	108	63
	3.9	2 9.2	2 14.2	2 9.0 †	2 119.2
	3.3	2 19.8	13.5	2 30.4	2 78.4
	8 2	2 33.0	2 22.4		
	5.1	12.4	6.6		
	5.0	7.5	9.2		
		10.0			
Average.....	5.1	10 2	9.4	9.8 †	49.4
Age in days: Dec. 26.	232	192	174	118	73
	8.1	2 22.6	2 15.2	2 4.2 †	2 18.4 †
	6.7	2 13.6	13.3	2 23.0	2 34.0
	8.4	2 18.0	2 20.2		
	6.7	10.5	5.9		
	5.3	6.4	6.5		
		2.3			
Average.....	7.0	8.2	8.7	6.8 †	13.1

(†) Sick, and off feed.

TABLE II—*Continued.*

Age in days: Jan. 5.	242	202	184	128	83
	7.0	2 13.4	2 21.0	2 14.8 †	2 3[illegible].6
	15.4	2 4.8 †	15.6	2 28.0	2 33 6
	6.8	2 19.6	2 23.6		
	5.4	8.1	11.7		
	6.2	7.0	8.0		
		9.2			
Average	8.2	6.9 †	11 4	10.7	16.3
Age in days: Jan. 15.	252	212	194	138	93
	3.7	2 17.8	2 12.6	2 14 4 †	2 43.6
	-0.8 †	2 20.2	8.4	2 14.4 †	2 35 0
	5.3	2 3.0	2 18.0		
	7.7	9 2	9.9		
	4 0	6.1	5.0 †		
		6.8			
Average .. .	5.2 †	7.0	7.7 †	7.2 †	19.6
Age in days: Jan. 25.	262	222	204	148	103
	6.0	2 14.4	2 16.8	2 20.0	2 36 0
	6.1	2 18.8	9.3	2 14.6 †	2 19.4 †
	8.4	2 23 2	2 22.2		
	7.2	9.6	8.0		
	8 2	5.7	9.7		
		5.9			
Average.....	7.2	8.9	9.4	8.6 †	13.8 †
Age in days: Feb. 4.	272	232	214	158	113
	5.2	2 13.4	2 10.0	2 14.8	2 33.0
	6.5	2 19.6	10.3	2 26.0	2 22.4
	3.1	2 11.6	2 15.0		
	5.2	5.6	7.8		
	2.4	5.0	4.4 †		
		7.9			
Average.....	4.5	7 0	6.8 †	10.7	13.9
Age in days: Feb. 14.	282	242	224	168	123
	3.0	2 9.6	2 7 4	2 13.8	2 28.2
	3 6	2 12.8	6.1	2 19.0	2 34.0 †
	2.4	2 5.0	2 10.8		
	4.6	5.3	5.4		
	5.1	3.4 †	2.8 †		
		4.4			
Average...	3.7	4.5 †	4 6 †	8.2	14.1 †

(†) Sick, and off feed.

TABLE III.—Increase per 100 pounds of live weight of pigs of same age after having been in part under full feed: (This is the previous table rearranged).

Number of days under full feed previous to date	9	49	69	9	29	89
Age in days.........	192	192	194	152	154	158
At date	Nov. 16	Dec. 26	Jan. 15	Nov. 16	Dec. 6	Feb. 4
	12.5 13.1 15.0 15.1 9.2	2. 22 6 2. 13.6 2. 18.0 10.5 6.4 2.3	2. 12.6 8 4 2. 18.0 9.9 5.0	2. 25.4 2. 28.0 2. 27.2 18.5 12 6 14.3	2 9.0 † 13.9 2. 29.8 7.5 7.6	2. 14.8 2. 26.0
Average	13.0	8.2	7.7	15.1	9.7 †	10.7
Age in days.........	202	202	204	162	164	168
	13.2 12.5 11.9 12.8 11.3	2. 13.4 2. 4 8 † 2. 19 6 8 1 7.0 9 2	2. 16 8 9 3 2. 22 2 8.0 9 7	2. 29 4 2. 33.4 2. 28.4 13.3 14.2 16.1	2. 14.2 13.5 2. 22.4 6.6 9.2	2. 13 8 2. 19.0
Average....	12 3	6.9 †	9.4	15.0	9.4	8.2
Age in days..........	212	212	214	172	174	178
	6.9 5 4 9.2 6.5 6.2	2. 17.8 2 21.2 2. 3.0 † 9.2 6.1 6.8	2 10 0 10.3 2. 15.0 7.8 4.4	2. 14.8 2. 17.4 2. 9.0 6.9 5.2 7.3	2. 15 2 13.3 2. 20.2 5.9 6.5	2. 14.4 2. 22.0
Average....... .	6 8	7.0	6.8	6.7	8.7	9.1

Number of days under full feed previous to date......	9	154 2. 9.0 13 9	C9	158 2. 14.8 2. 26.0
Age in days.........	134	2. 29 8 7.5	138	
At date..	Nov. 16	7.6	Jan. 15	
	2. 29.0 18.8 2. 40.2 16.8 10.8	9.7	2. 14.4 2. 14.4	10.7
Average...........	16.5		7 2	
Age in days	144		148	
	2. 39.6 16.7 2. 27.2 17.6 17.3		2. 20 0 2. 14.6	
	16 9		8.6	

lesson is well observed already, but for a different reason than the one given here: the younger and feebler animals are pushed aside at feeding time by the older and stronger ones and suffer in consequence, yet this is, evidently, the case only where feeding falls short of the animals' ability to eat, and when this point is reached all must get *enough*. It is then that the fact, pointed by the table, manifests itself and, while very close feeding may obviate, in a measure, both difficulties, it is plainly wiser to follow the suggestion made here than to take the risk resulting on the one hand from under-feeding and on the other, which in reality is much more serious, from overfeeding. The facts supporting the two points made are brought out so plainly by the two tables following as to need no further explanations.

COST IN CENTS PER POUND OF GROWTH.

Since the Station paid for the corn and wheat consumed during the trial the same prices, 1 cent a pound for chops, or per bushel 55 cents for wheat and 50 cents for corn, the cost in cents per pound of growth must closely follow the previous table; yet prices are always readily apprehended and, perhaps, better adapted for the practical purposes of this discussion so that a special table can not be without value:

POUNDS OF FOOD FOR ONE POUND OF GROWTH.

A glance at the table reveals peculiar irregularities. While, in a general way, the quantity of food to make one pound of growth increases with the age of the animals, the amount sometimes rises suddenly and irregularly to a strikingly high figure. The food is consumed and yet there is no growth or, in other words, no increase in weight, and to say what becomes of it might be a difficult matter. That it has something to do with a temporary loss of health is plain enough; but to what extent indisposition, whether mere indigestion or febrile affection, is the cause of it, is by no means easy to determine.

It was thought at first that the very cold weather, of which we had during the winter several spells, might account for these sudden rises, but on inspecting a table of the average daily temperatures during the ninety days of experiment, no apparent connection between the two can be traced. While, therefore, cold demands additional food to supply the greater amount of heat needed by the animal body, the irregular and high figures in the case of nearly every one of the animals at some period or periods of trial remain unexplained. As to the feed, wheat makes a good showing; not so much as whole wheat, No. VI, as in that of wheat chops, No. III, IV and V. Potatoes and artichokes, it is plain, are out of the question as a profitable food supply to pigs, unless they could be raised at greatly reduced figures than those assumed here. That this might well be done is not at all unlikely.

TABLE IV.—Pounds of food for 1 pound of increase in live weight for the ten daily and monthly periods:

Lot Number.		November 16	November 26	December 6	December 16	December 26	January 5	January 15	January 25	February 4	February 14	First month	Second month	Third month
I		3.2	3.7	5.9	8.1	3.8	4.9	4.9	5.2	5.6	6.8	5.2	4.4	5.8
II		3.1	3.3	9.2	6.7	5.2	2.9	9.7	4.9	6.6	8.1	5.3	4.7	6.2
III		3.1	3.7	4.9	4.4	4.8	7.6	4.2	3.9	6.0	6.1	4.3	5.2	5.1
IV		2.6	4.3	6.8	3.1	4.0	3 4	8.8	3.2	4 2	7.2	4.2	4 5	4.3
V		2.6	4.3	4.1	3.4	4.2	3.9	4.1	3.6	4.9	5.5	3.9	4.0	4.5
VI		3.0	3.6	6.0	6.2	5.5	4.7	4.7	5.9	6.2	7.4	4.1	4.9	6.4
VII		3.5	3.6	7.1	5.5	7.6	4 7	6.6	4.5	7.7	7.8	5.4	6.1	6 3
VIII	Wheat			4.2	3.5	2.6	2.4	3.4	2.2	4.0	3.1	3.4	3.2	40 days.
	Potats			4 2	9.4	10.2	9.5	13.8	7.3	12.9	8.9	8.0	8.4	
IX	Wheat			6 8	2.3	2.4	2 8	2.5	9.7	13.0	5.0	3.3	3 2	40 days.
	Artich			6 8	6.6	9.7	11.1	5 5				7.8	8 6	

TABLE V.—Cost in cents of 1 pound of increase of live-weight for the ten daily and monthly periods:

Lot Number.	November 26—Preliminary........	November 29......	December 6.......	December 16	December 26.......	January 5..........	January 15.........	January 25.........	February 4........	February 14........	First month.	Second month....	Third month......
I..................	3.05	3.52	5.65	7 73	3.58	4.70	4.72	4.98	5.20	6.50	4.96	4 27	5.50
II..................	2.98	3.16	8.78	6.01	4.99	2.75	9 23	4.65	6.26	7.74	4.92	4.51	5.92
III................	2.98	3.53	4.64	4.15	4.52	7.23	4.00	.3 74	5.71	5 81	4.01	4.90	4.87
IV.................	2.63	4.27	6.77	3.69	4.05	3.37	8.78	3.18	4.17	7.18	4.24	4.53	4.30
V..................	2 64	4 32	4.09	3.39	4.22	3.86	4.08	3.60	4.95	5.52	3.92	4.05	4.51
VI.................	2.60	3.19	5.22	5.42	4.75	4.07	4.40	5.22	5.39	6.45	4.27	4.27	5.62
VII................	3.05	3.11	6.16	4 77	6.61	4 12	5 75	3.90	6.69	6.81	4.36	5.27	5.45
VIII.....			3.97	9.82	9.41	8.81	12.66	7.04	12.61	9.04	10.05	10 00	40 days.
IX			10.23	3.96	4.87	8 39	4.25	8.78	11.70	4.47	6.40	6.17	

CONCLUSIONS.

The conclusions are based on the general statement embodied in

TABLE VI.—Statement of results for whole time of trial:

Lot Number.	Weight in pounds. Nov. 16	Weight in pounds. Feb. 14	Increase. Per cent.	Pounds of food for 1 pound of gain.	Cost of food Eaten.	Cost in cents of 1 pound of increase.
I............	415.5	787	89.4	5.13	$ 18.14	4.88
II.....	400.5	762	90.2	5.40	$ 18.42	5.09
III...........	412	818	98.5	4.90	$ 18.57	4.58
IV..........	394	894	126.9	4 33	$ 21.77	4.36
V...........	400.5	940	134.7	4.13	$ 22.47	4.17
VI..........	406	768	89.1	5.13	$ 17 06	4.71
VII..........	396.5	730	84.1	5.93	$ 16.62	4.98
VIII,.......	521.5	761	45.9	3.30 wheat	$ 22.75	9.50 *
	521.5	881	68.8	8.20 potats	$ 34.12	9.50 ‡
IX..........	528.0	728	37.9	3 25 wheat	$ 13.30	6.65 *
	528.0	828	56.8	8.20 artich	$ 19.95	6.65 ‡

* Two months.

‡ Calculated for three months.

The superiority of wheat over corn for the purposes of feeding, both as to per cent and cost of increase, is clear; it is also also clear that wheat chop is superior to whole wheat, whether the latter be soaked or mixed with bran, or be given clear. Lot V. made the best and cheapest growth, increasing 134.7 per cent in weight, at a cost of 4.17 cents per pound at the comparative high valuations of our food materials. It is true, this lot contained two phenomenal animals, increasing from 124 and 112 pounds at the beginning to 318 and 339 pounds at the end of the trial; but whether this exceptional growth was owing to superiority of breed or feed, wheat chop soaked for thirty-six hours, resulting in steady growth, without sickness and without sudden and ineffectual increase in the food consumed, as previously alluded to, must be left undecided. Next in merit comes lot IV., whose feed was wheat chop fed dry. These two lots exceed all the others and deserve chief consideration on the part of practical feeders.

Wheat chop and bran, lot III., and whole wheat, whether soaked or fed dry, lots VII. and VI., are about equal to corn, lot I. In these four lots, the bran fed amounted to exactly one-fifth by weight of the feed given, and need for this reason not be specially considered. The number of pounds of growth, then, which one bushel has made in the case of wheat and corn is as follows:

One bushel of wheat (*chop, soaked*) made 13.2 pounds of growth.

One bushel of wheat (*chop*) made 12.6 pounds of growth.

One bushel of wheat (*whole*) made 11.4 pounds of growth.

One bushel of corn (*chop*) made 10.3 pounds of growth.

THE NUTRITIVE RATIO.

A simple consideration of the effects of food upon the animal body leads to the conclusion that all are not equally nourishing; the cause of this is a two-fold one: First, all foods do not contain the nutritive elements in the same proportion, and, second, the digestibility of these elements in different foods is different. Now, it is plain that whatever is not digestible, and passes through and out of the body in the same form in which it entered, can have no effect upon growth; it is necessary, therefore, in the valuation of food to determine this digestible portion as well as the proportion of the nutritive elements which it contains. These nutritive elements by common consent are taken to be protein, fat, extractive matter and fibre. If, then, the digestible portion in any feeding stuff of each of these four substances is known, we may form an estimate of its feeding value. These proportions, ascertained by long series of analyses and experiments, are found in the standard publications on the subject and need not be re-stated here.

Now, experience has demonstrated that, to obtain the best results possible, protein must be in a certain proportion to the rest of the nutrients; this proportion, of course, differs for the different kinds and ages of animals, and is given for growing pigs, five or six months old and weighing 135 pounds, more or less, as 1:5. To ascertain, then, the nutritive ratio in any feed, multiply the fat by two and one-half and add the product to the extractive matter and fibre, and divide the sum by the protein, as follows:

Corn, composition of:

7.1 per cent of protein, digestible.

3.6 per cent of fat, digestible.

1.5 per cent of fibre, digestible.

61.5 per cent of extractive matter, digestible.

3.6 multiplied by 2½ equals 9.0, plus 1.5 plus 61.5 equals 72.0.

72.0 divided by 7.1 equals 10.1, the nutritive ratio. The nutritive ratio, then, is: of

Wheat,	1:6.5.
Corn,	1:10.1.
Bran,	1:4.
Peas,	1:3.2.

It is seen that neither wheat nor corn, clear, are advantageous feeds for growing pigs; even with the proportion of bran used in the experiments the nutritive ratio of the mixtures becomes only 1:6 for wheat and bran, and 1:9 for corn and bran, both leading to waste. Some addition of a highly nitrogenous feed to either is necessary for profitable feeding, and, as a suggestion, peas are taken to compound the feed:

Two parts of wheat and one part of peas give a nutritive ratio of 1:5.4.

Two parts of peas and one part of corn give a nutritive ratio of 1:6.0.

If, in addition, one part of bran be added to each, the nutritive ratio becomes for the former 1:5, and for the latter 1:5.5, either of which would, doubtless, give better results than are here attained, and such as would return a satisfactory profit.

RE-STATEMENT OF RESULTS:

1. Pigs, with increasing age, diminish their rate of increase.

2. Pigs put rather young upon full feed do not maintain their rate of increase, but fall behind others that are older and less long on full feed.

3. The fattening process for pigs, to be profitable, must be short; perhaps not longer than two months.

4. Wheat as a food for growing pigs is superior to corn, weight for weight.

5. Neither wheat nor corn give the best results, when fed alone; both should be mixed with a food rich in nitrogen, such as peas.

6. Very young pigs cannot be reared at all on a clear wheat diet.

TABLE VII.—Daily mean temperature in degrees Fahrenheit for the ten days of each period ending at the dates given.

	November 16..	November 26..	December 6 ...	December 16..	December 26..	January 5.....	January 15 ...	January 25 ...	February 4....	February 14...	First month...	Second month.	Third month..
	50	25	48	60	34	14	37	30	10	2			
	42	38	30	50	36	12	34	34	4	15			
	37	24	34	40	44	26	18	48	8	-2			
	26	45	43	39	49	25	18	45	13	-4			
	24	38	42	38	55	24	27	54	8	10.			
	40	54	32	38	40	26	16	43	22	13			
	47	39	26	40	38	34	4	32	10	10			
	41	40	36	44	45	26	14	24	6	15			
	62	47	44	46	34	18	20	16	12	15			
	43	59	44	44	28	29	31	20	-4	24			
Average........	41.2	40.9	37.9	43.9	40 3	23.4	21 9	34.6	8.9	9.8	40.9	28.5	17.8

TABLE 1.—Complete Statement of Feeding Trial with Pigs.

Lot Number	Ear Tag	Age in days	November 7. Weight in pounds	November 16. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain
I.	152	192	148.5	167	18.5	12.5		
	166	152	119	132	13	12.7		
	162	152	101.5	116.5	15			
			369	415.5	46.5	12.6	149 $1.42	3.2
II.	155	192	144.5	163.5	19	13.1		
	163	134	105	121.5	16.5	14.5		
	182	134	102	115.5	15.5			
			351.5	400.5	49	13.9	153 $1.46	3.1
III.	151	192	160	184	24	15.0		
	158	152	104	118.5	14.5	14.0		
	161	152	96	109.5	13.5			
			360	412	52	14.4	162.5 $1.55	3.1
IV.	163	152	112	134.5	22.5	18.6		
	164	152	119	139.5	20.5			
	171	134	101	120	19	18.8		
			332	394	62	18.7	163 $1.63	2.6
V.	160	152	124	147	23	18.5		
	170	134	99	120.5	21.5	20.1		
	175	134	112	133	21			
			335	400.5	65.5	19.6	172.5 $1.73	2.6
VI.	156	192	142.5	164	21.5	15.1		
	165	152	119	134	15	14.4		
	178	134	92.5	108	15.5			
			354	406	52	14.6	154 $1.35	3.0
VII.	157	192	146.5	160	13.5	9.2		
	167	152	108.5	124	15.5	12.6		
	161	134	101.5	112.5	11			
			356.5	396.5	40	11.2	140 $1.22	3.5
VIII.	153	192						
	178	134						
	177	134						
IX.	154	192						
	180	134						
	168	134						
X.	84	78	37	37.5	.5			
	86	78	36	38	2			
			73	75.5	2.5	3.4	29	11.6
XI.	83	78	40	47	7			
	84	78	36	40	4			
			76	87	11	14.5	51	4.5
XII.	91	33						
	88	33						
			20.5	25	4.5	21.9	9 lb wheat. milk, lib, new.	2.0
XIII.	89	33						
	90	33						
			20	24	4	20.0	5 lb meal. milk, lib, new.	1.2

Lot Number	November 26. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain	December 6. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain
I.	189	22	13.2			202	13	6.9		
	149	17	14.7			158	9	7.4		
	136	19.5				148	12			
	474	58.5	14.1	216 $2.06	3.7	508	34	7.2	202 $1.92	5.9
II.	184	20.5	12.5			194	10	5.4		
	144	22.5	19.8			152	8	4.5		
	140	24.5				145	5			
	468	67.5	16.9	225 $2.13	3.3	491	23	4.9	211.5 $2.02	9.2
III.	206	22	11.9			225	19	9.2		
	138	19.5	16.7			148	10	8.7		
	128	18.5				141	13			
	472	60	14.5	222.5 $2.12	3.7	514	42	8.9	206 $1.95	4.9
IV.	150	15.5	14.2			188	18	4.5		
	163	23.5				159	-4			
	140	20	16.7			159.5	19.5	13.9		
	453	59	14.9	252 $2.52	4.3	486.5	33.5	7.4	226.5 $2.27	6.8
V.	166.5	19.5	13.3			178	11.5	6.9		
	134	13.5	13.6			150	15	14.9		
	154	21				181	27			
	454.5	54	13.5	233 $2.33	4.3	509	54.5	12.0	223 $2.23	4.1
VI.	185	21	12.8			197	12	6.5		
	153	19	15.7			161	8	6.3		
	127	19				136.5	9.5			
	465	59	14.5	215 $1.88	3.6	494.5	29.5	6.4	177.5 $1.54	6.0
VII.	178	18	11.3			189	11	6.2		
	144	20	16.7			154.5	10.5	7.4		
	132	19.5				142	10			
	454	57.5	14.5	206 $1.79	3.6	485.5	31.5	6.9	224.5 $1.94	7.1
VIII.	203					215	13	6.4		
	126					135	9	9.2		
	124					138	14			
	453					489	36	7.9	150 lb wheat chops. 150 lb potatoes. $1.50 $1.00	4.2 wheat 4.2 potats
IX.	207.5					214	8.5	3.1		
	124					134	10	6.2		
	124.5					130	5.5			
	456					478	22	4.8	150 lb wheat chops. 150 lb artichokes. $1.50 $0.75	6.8 wheat 8.8 artich
X.	45.5	8				44	-1.5			
	40	2				45	5			
	85.5	10	13.2	85	3.5	89	3.5	4.1	33.5	9.8
XI.	52	5				56	4			
	44.5	4.5				49	4.5			
	90.5	9.5	10.9	49	5.2	105	8.5	8.8	47	5.5
XII.	40.5	15.5	62.0	15 lb wheat 60 lb milk, skimmed.	1.0 wheat. 8.9 milk.	54.5	14	34.0	16 lb wheat 50 lb milk.	1.2 wheat 4.8 milk
XIII.	39.5	15.5	64.0	14 lb meal. 60 lb milk, skimmed.	0.9 meal. 3.0 milk.	51	11.5	29.1	21 lb meal. 60 lb milk.	1.8 meal 5.2 milk

Lot Number	December 16. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain	December 26. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain
I.	210	8	3.9			227	17	8.1		
	171	18	4.6			184	18	11.3		
	149	1				172	28			
	530	22	4.3	179 $1.70	8.1	563	53	10.0	200 $1.90	3.8
II.	200.5	6.5	3.3			214	13.5	6.7		
	162	10	7.1			178	16	7.6		
	156	11				164	8			
	518.5	27.5	5.6	185 $1.66	6.7	556	37.5	7.3	196 $1.87	5.2
III.	243.5	18.5	8.2			204	20.5	8.4		
	162.5	14.5	9.9			178	15.5	6.8		
	155	14				151	8			
	561	47	9.1	206 $1.95	4.4	603	42	7.5	200 $1.90	4.6
IV.	185.5	17.5	16.5			205	19.5	9.0		
	195.5	36.5				214	18.5			
	181	21.5	13.5			205	24	13.3		
	562	75.5	15.5	233 $2.33	3.1	624	62	11.0	251 $2.51	4.0
V.	200	22	12.4			221	21	10.5		
	168	18	11.2			184	18	10.1		
	200	19				221	21			
	568	59	11.6	200 $2.00	3.4	626	58	10.2	245 $2.45	4.2
VI.	207	10	5.1			221	14	6.7		
	173	12	7.5			184	11	6.1		
	145.5	9				154	8.5			
	525.5	31	0.4	191 $1.68	6.2	559	33.5	6.4	183 $1.59	5.5
VII.	198.5	9.5	5.0			209	10.5	5.3		
	170	15.5	9.6			174	4	4.3		
	155	13				165	10			
	523.5	38	7.8	209 $1.81	5.5	548	24.5	4.7	187 $1.62	7.8
VIII.	221.5	5.5	2.5			233	11.5	5.2		
	150	15	9.9			162	12	8.7		
	150	12				164	14			
	521.5	32.5	6.7	116 lb wheat chops. 306 lb potatoes. $1.15 $2.04	3.5 wheat 9.4 potats	559	37.5	7.2	97 lb wheat chops. 384 lb potatoes. $0.97 $2.56	2.6 wheat 10.2 potats
IX.	230	10	7.5			246	16	7.0		
	150	16	12.9			162	12	8.0		
	148	18				160	12			
	528	50	10.5	106 lb wheat chops. 330 lb artichokes. $1.16 $1.65	2.3 wheat 6.8 artich	568	40	7.5	98 lb wheat chops. 388 lb artichokes. $0.98 $1.94	2.4 wheat 9.7 artich
X.	47	3				40	1			
	46	1				49	3			
	93	4	4.5	31	7.7	95	2	2.1	36	15.0
XI.	66	10				72	6			
	55	6				63	8			
	121	10	15.2	41	2.5	135	14	11.5	53	5.7
XII.	49					50	7			
	38					39	1			
	87	32.5	59.6	41 lb wheat. 80 lb milk.	1.3 wheat. 2.5 milk.	95	8	9.2	34 wheat. 80 milk.	4.2 wheat. 10.0 milk.
XIII.	33					42	9			
	38					41	3			
	71	20	39.2	30 meal. 72 milk.	1.5 meal. 3.6 milk.	83	12	17.0	35 meal. 80 milk.	2.9 meal. 8.7 milk.

Lot Number	January 5. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain	January 15. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain
I.	243	16	7.0			252	9	3.7		
	197	13	6.7			214	17	8.9		
	183	11				200	17			
	623	40	6.0	198 $1.88	4.9	666	43	6.9	213 $2.03	4.9
II.	247	33	15.4			245	-2	-0.8		
	197	19	10.5			211	14	6.3		
	181	17				191	10			
	625	59	12.4	200 $1.90	2.9	647	22	3.5	213 $2.03	9.7
III.	282	18	6.8			297	15	5.3		
	185	8	2.4			200	14	10.1		
	161	0				182	21			
	829	26	4.3	197.5 $1.88	7.8	579	50	7.9	211 $2.00	4.2
IV.	237	32	9.8			231	-6	1.5		
	223	9				236	13			
	237	32	15.6			257	20	8.4		
	697	73	11.7	240 $2.40	3.4	724	27	3.9	237 $2.37	8.8
V.	230	18	8.1			261	22	9.2		
	204	20	11.8			224	20	9.0		
	249	28				270	21			
	602	68	10.5	235 $2.55	3.9	755	53	9.1	257 $2.57	4.1
VI.	233	12	5.4			251	18	7.7		
	197	13	9.2			209	12	7.9		
	172	18				189	17			
	602	43	7.7	201 $1.75	4.7	649	47	7.8	222 $1.98	4.7
VII.	222	13	6.2			232	10	4.0		
	190	16	8.6			203	13	5.7		
	178	13				187	9			
	590	42	7.7	190 $1.73	4.7	622	32	5.4	211 $1.84	6.6
VIII.	243	10	4.3			250	7	2.9		
	180	18	9.8			190	10	6.1		
	178	14				190	12			
	001	42	7.5	103 lb wheat chops. 400 lb potatoes. $1.03 $2.67	2.4 wheat 9.5 potats	630	29	4.8	100 lb wheat chops. 400 lb potatoes. $1.00 $2.67	3.4 wheat 13.8 potats
IX.	258	12	4.9			281	23	8.0		
	174	12	7.4			188	14	7.8		
	172	12				185	13			
	504	36	6.3	102 lb wheat chops. 400 lb artichokes. $1.02 $2.00	2.8 wheat 11.1 artich	554	50	8.2	125 lb wheat chops. 173 lb artichokes. $1 25 $0 87	
X.	53	7				58	5			
	49	0				52	3			
	102	7	7.4	35	5.0	110	8	7.2	41	5.1
XI.	84	12				90	8			
	70	7				75	5			
	154	19	14.0	64	8.4	165	11	7.2	65	5.0
XII.	64	8				76	12			
	46	7				58	12			
	110	15	15.8	42 wheat 80 milk	2.8 wheat 5.3 milk	134	24	21.8	50 wheat 80 milk	2.1 wheat 3.3 milk
XIII.	50	8				59	9			
	47	6				55	8			
	07	14	16.8	31 meal 80 milk	2.2 meal 5.7 milk	114	17	17.5	40 meal 80 milk	2.4 meal 4.7 milk

Lot Number	January 25. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain	February 4. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain
I.	267	15	6.0			281	14	5.2		
	230	16	7.2			244	14	6.7		
	214	14				230	16			
	711	45	6.8	235 $2.24	5.2	755	44	6.2	240 $2.33	5.6
II.	260	15	6.1			277	17	0.5		
	229	18	8.4			233	4	5.0		
	207	16				225	18			
	696	49	7.6	240 $2.28	4.9	735	39	5.6	257 $2.44	5.8
III.	322	25	8.4			332	10	3.1		
	215	15	9.4			234	19	9.8		
	203	21				215	12			
	740	01	9.0	240 $2.28	3.9	781	41	5.5	247 $2.34	8.0
IV.	208	37	11.6			281	15	5.8		
	253	17				267	14			
	281	24	9.3			310	29	10.3		
	802	78	10.7	248 $2.48	3.2	861	59	7.4	240 $2.48	4.2
V.	286	25	9.6			302	16	5.0		
	248	24	11.1			268	20	7.5		
	301	31				322	21			
	835	80	10.6	287 $2.87	3.6	892	57	6.8	282 $2.82	4.9
VI.	259	18	7.2			283	14	5.2		
	221	12	6.8			232	11	6.4		
	204	15				220	16			
	294	45	6.9	265 $2.35	5.9	735	41	5.9	253 $2.21	6.2
VII.	251	19	8.2			257	8	2.4		
	215	12	7.7			232	17	6.2		
	205	18				214	9			
	871	49	7.9	220 $1.91	4.5	703	32	4.9	245 $1.14	7.7
VIII.	265	15	6.0			273	8	3.0		
	209	19	10.5			223	14	5.5		
	211	21				220	9			
	685	55	8.7	120 lb wheat chops. 400 lb potatoes. $1.20 $2.67	2.2 wheat 7.3 potats	715	31	4.5	124 lb wheat chops. 400 lb potatoes. $1.24 $2.67	4.0 wheat 12.0 potats
IX.	282	1	0.4			285	3	1.1		
	200	12	5.9			205	5	2.5		
	195	10				200	5			
	677	23	3.5	224 $2.02	9.7	690	13	1.0	160 $1.52	13.0
X.	63	5				70	7			
	58	0				60	2			
	121	11	10.0	47	4.3	130	9	7.4	49	5.4
XI.	95	5				105	10			
	82	7				95	13			
	177	12	7.3	66	5.5	200	23	13.0	70	6.0
XII.	88	12				104	16			
	70	12				80	10			
	158	24	18.0	61 wheat 00 milk	2.5 wheat 8.7 milk	184	26	16.5	60 wheat 90 milk	2.3 wheat 3.5 milk
XIII.	63	4				77	14			
	52	7				52	0			
	125	11	9.7	47 meal 90 milk	4.3 meal 8.2 milk	139	14	11.2	41 meal 90 milk	2.0 meal 6.4 milk

Lot Number	February 14. Weight in pounds	Gain, pounds	Gain per 100 pounds of live weight	Food eaten, pounds	Pounds of food for one pound of gain
I.	290	9	3.0		
	255	11	4.8		
	242	12			
	767	32	4.2	219 $2.08	6.8
II.	287	10	3.6		
	240	7	3.7		
	235	10			
	762	27	3.7	220 $2.09	8.1
III.	340	8	2.4		
	245	11	6.4		
	233	18			
	818	37	4.7	222 $2.15	6.1
IV.	290	6	2.5		
	275	8			
	320	19	6.1		
	894	33	3.9	237 $2.37	7.2
V.	318	10	5.3		
	283	15	5.4		
	339	17			
	910	48	5.4	265 $2.65	5.5
VI.	290	13	4.6		
	240	8	4.4		
	282	12			
	768	33	4.5	243 $2.13	7.4
VII.	270	13	5.1		
	240	8	3.1		
	220	5			
	730	27	3.8	212 $1.84	7.8
VIII.	285	12	4.4		
	240	17	7.4		
	236	16			
	701	45	6.3	140 lb wheat chops. 400 lb potatoes. $1.40 $2.67	3.1 wheat 8.9 potats
IX.	298	13	4.6		
	217	12	0.2		
	213	13			
	728	38	5.5	189 $1.70	5.0
X.	70	5			
	63	3			
	139	9	6.9	51	5.7
XI.	117	12			
	102	7			
	219	10	9.5	79	4.2
XII.	119	15			
	01	11			
	210	20	14.1	75 wheat 90 milk	3.9 wheat 3.5 milk
XIII.	70	-7			
	sick				
				8[illegible] meal. 90 milk.	